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REPORT

OF THE

UNITED STATES COMMISSIONER OF FISHERIES

FOR THE FISCAL YEAR 1913

WITH

APPENDIXES

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REPORT OF THE UNITED STATES COMMISSIONER OF FISHERIES FOR THE FISCAL YEAR ENDING JUNE 30, 1913

Bureau of Fisheries Document 782

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REPORT

OF THE

COMMISSIONER OF FISHERIES.

DEPARTMENT OF COMMERCE,
BUREAU OF FISHERIES,
Washington, December 13, 1913.

SIR: There is submitted herewith a report giving an outline review of the operations of the Bureau of Fisheries during the fiscal year ended June 30, 1913.

PROPAGATION AND DISTRIBUTION OF FOOD FISHES.

GENERAL EXTENT OF THE WORK.

In this most extensive and important branch of the Bureau of Fisheries no material changes were made in 1913 in the methods heretofore pursued, but the extension of the work into new fields through the establishment and operation of inexpensive auxiliary stations at advantageous points resulted in an output exceeding that of any previous year, though the available expenditures were not increased. In other words, notwithstanding the higher cost of labor and materials the Bureau has succeeded in producing fish at a smaller cost per unit than ever before.

The outcome of fish-cultural operations in any given field is governed largely by local climatic conditions prevailing during the comparatively short spawning seasons of the various species. Storms, freshets, and drought prevent the ascent of river fish to their spawning grounds, rendering ineffective the preparations made for taking their eggs; abnormal heat or cold, with sudden changes in water temperature, may cause heavy losses of eggs and fry in the early stages of development; still other natural agencies often interfere with the most carefully planned operations. The most serious conditions with which the Bureau has to contend, however, are of an artificial nature. The construction of dams without efficient fishways; the operation of nets in prohibited waters or at the mouths of streams, thus preventing the adult fish from reaching their spawning grounds; and the destruction of fishes and fish food through water pollution, are some of the factors which nullify the fish-cultural work of the Bureau in some sections of the country; while the failure of some of the States to enact or enforce adequate protective laws, and the disposition of others to appropriate to their own use fields which have been developed and are already occupied by the Bureau, tend to hamper and curtail its activities.

Despite the scope and magnitude of its operations, the Bureau has difficulty, with its present facilities, in meeting the constantly growing demands from all sections of the country for fish to stock public and private waters. Salmonoid fishes, which are propagated by the artificial manipulation of the eggs, can be produced in sufficient numbers; but with a fuller realization of the benefits accruing from the maintenance of fish ponds on farms, as an inexpensive and ready food supply for home consumption, the demands for the black basses, crappies, sunfishes, catfishes, and other species adapted to pond culture, which are obtainable only through natural reproduction, have increased out of all proportion to the annual supplies available.

Following is a summarized statement of the output of food and game fishes during the fiscal year 1913. The total production, amounting to more than 3,863,000,000, showed a substantial gain over the previous year. More than 85 per cent of the product was distributed in the form of fry, and over 10 per cent was fertilized eggs which were either transferred to outside agencies for the completion of incubation or planted on the natural spawning grounds because of overcrowded condition of the hatcheries. The 45 species handled include the most important fishes of the coastal and interior waters.

SUMMARY, BY SPECIES, OF THE DISTRIBUTION OF FISH AND FISH EGGS DURING THE FISCAL YEAR 1913.

Species.	Eggs.	Fry.	Fingerlings, yearlings, and adults.	Total.
Catfish			62,446	62,446
Carp			79,160	79,160
Buffalofish		3,080,000	4,212	3,084,212
Shad	3,394,000	133,244,850		136,638,850
Whitefish	73,720,000	393,880,000		467,600,000
Lake herring		4,730,000		4,730,000
Silver salmon	102,000	14,184,283	69,800	14,356,083
Chinook salmon	38,583,873	33,319,423	97,760	72,001,056
Blueback salmon	2,000,000	80,340,902		82,340,902
Humpback salmon		153,680		153,680
Dog salmon		19,479,000		19,479,000
Steelhead trout	980,000	4,300,225	138,410	5,418,635
Rainbow trout	1,106,000	901,370	1,150,957	3,158,327
Atlantic salmon		3,492,464	4,304	3,496,768
Landlocked salmon	224,000	253,546	80,196	557,742
Black-spotted trout	13,305,000	766,950	7,174,060	21,246,010
Loch Leven trout			75,200	75,200
Lake trout	6,612,000	20,594,600	3,024,924	30,231,524
Brook trout	1,239,000	5,280,452	6,014,645	12,534,097
Grayling	903,000	2,613,000		3,516,000
Smelt	4,500,000	1,850,000	27,000	6,377,000
Pike and pickerel			9,004	9,004
Crappie and strawberry bass			79,279	79,279
Rock bass			64,743	64,743
Warmouth bass			1,390	1,390
Small-mouth black bass		234,300	107,641	341,941
Large-mouth black bass		26,250	1,231,052	1,257,302
Sunfish (bream)			203,623	203,623
Pike perch	46,200,000	148,510,000		194,710,000
Yellow perch	11,000,000	365,723,000	25,132	376,748,132
White perch	20,000,000	449,120,000	721	469,120,721
Striped bass		7,234,000		7,234,000
Yellow bass			255	255
Cod	6,800,000	221,012,000		227,812,000
Pollock	133,739,000	430,060,000		563,799,000
Haddock	57,868,000	68,257,000		126,125,000
Flatfish		809,270,000		809,270,000
Lobster		199,680,000	200	199,680,200
Total	422,275,873	3,421,591,295	19,726,114	3,863,593,282

The distribution of this output necessitated 641,250 miles of travel, 123,394 of which were performed by the Bureau's cars and the remainder by detached messengers. All transportation was paid for with the exception of 12,314 miles of car travel and 81,355 miles by messengers.

STATIONS OPERATED.

The permanent hatcheries operated in 1913 numbered 34, and the subhatcheries, auxiliaries, and egg-collecting stations numbered 102. These were located in 30 States and Alaska. The hatcheries may be conveniently classified as follows:

Location and character of operations.	Number.
Atlantic rivers, for salmon, shad, striped bass, yellow perch, and white perch	4
Pacific rivers, for salmon and steelhead trout	5
Great Lakes, for whitefish, cisco, lake trout, and pike perch	4
Interior waters, for bass, sunfish, crappie, trout, etc.	18
Atlantic coast, for cod, haddock, pollock, flounder, and lobster	3
Total	34

A full list of the hatcheries operated, and the subsidiary stations under each, with the period of operation and the species handled, is here given. The main stations, arranged in alphabetical order, are those for which a superintendent and other employees are provided by law. The subordinate stations, which are sometimes as fully equipped and important as the others, but have no special superintendent and often no permanent personnel whatever, are arranged under their respective head stations.

FISH-CULTURAL STATIONS OPERATED DURING THE FISCAL YEAR 1913.

Designation.	Period of operation.	Species handled.
Afognak, Alaska	Entire year	Blueback and humpback salmon.
Eagle Harbor, Alaska	May 30–June 30	Blueback salmon.
Uganak Lake, Alaska	June 11–June 30	Do.
Baird, Cal.	Entire year	Chinook salmon.
Battle Creek, Cal.	Oct.–Jan.	Do.
Hornbrook, Cal.	Oct.–May	Silver salmon and rainbow trout.
Mill Creek, Cal.	Oct.–Jan.	Chinook salmon.
Baker Lake, Wash.	Entire year	Chinook, blueback, and silver salmon and steelhead trout.
Birdsview, Wash.	do.	Chinook, blueback, silver, dog, and humpback salmon and steelhead trout.
Brinnon, Wash.	do.	Dog salmon and steelhead trout.
Darrington, Wash.	do.	Silver, chinook, and dog salmon and steelhead trout.
Duckabush, Wash.	do.	Chinook, silver, and dog salmon and steelhead trout.
Elwell Creek, Wash.	Sept. 11–June 30	Chinook and silver salmon and steelhead trout.
Illabott Creek, Wash.	Entire year	Chinook, silver, and dog salmon and steelhead trout.
Quilcene, Wash.	do.	Silver and dog salmon and steelhead trout.
Battery, Md.	May 6–May 25	Yellow perch, shad, and white perch.
Boothbay Harbor, Me.	Entire year	Cod, flatfish, haddock, and lobster
Portland, Me.	July 1–Nov. 30; May 5–June 30	Lobster.

FISH-CULTURAL STATIONS OPERATED DURING THE FISCAL YEAR 1913—Continued.

Designation.	Period of operation.	Species handled.
Bozeman, Mont	Entire year	Brook, black-spotted, rainbow, steelhead, and lake trout and grayling.
O'Dell Creek, Mont	Apr. 1–May 12	Grayling.
Red Rock, Mont	May 1–June 30	Do.
South Meadow Creek, Mont	Apr. 1–June 26	Grayling and rainbow trout.
Yellowstone Park, Wyo	July 1–Sept. 10; June 6–June 30	Black-spotted trout.
Beaver Dam, Wyo	July 23–July 27	Do.
Clear Creek, Wyo	July 5–July 27	Do.
Columbine Creek, Wyo	July 9–July 19	Do.
Cub Creek, Wyo	July 5–Aug. 20	Do.
Lake Camp, Wyo	July 1–Sept. 10; June 6–June 30	Do.
Thumb Camp, Wyo	July 1–Aug. 17; June 12–June 30	Do.
Bryan Point, Md	Feb. 11–May 22	Yellow perch and shad.
Cape Vincent, N. Y	Entire year	Whitefish, cisco, lake, brook, and rainbow trout, pike perch, yellow perch, and landlocked salmon.
Mud Creek, N. Y	Apr	Pike perch.
Three Mile Bay, N. Y	Nov	Whitefish and cisco.
Clackamas, Oreg	Entire year	Chinook and silver salmon, brook, rainbow, black-spotted, and steelhead trout.
Applegate Creek, Oreg	Sept. 10–May 31	Silver salmon and steelhead trout.
Big White Salmon River, Wash.	Aug. 1–Feb. 28	Chinook salmon.
Eagle and Tanner Creeks, Oreg.	Sept. 1–Oct. 31	Do.
Eagle Creek, Oreg	Apr. 1–June 20	Steelhead trout.
Illinois River, Oreg	Sept. 1–Jan. 1	Chinook and silver salmon.
Little White Salmon River, Wash.	Entire year	Chinook salmon.
Lower Rogue River, Oreg	Aug. 15–Mar. 31	Do.
Rogue River, Oreg	Entire year	Chinook and silver salmon, steelhead and black-spotted trout.
Upper Clackamas River, Oreg.	do	Chinook and silver salmon, and steelhead trout.
Willamette Falls, Oreg	June 15–July 15	Shad.
Cold Springs, Ga	Entire year	Large-mouth black bass, sunfish, and catfish.
Harris Pond, Ga	do	Catfish and sunfish.
Craig Brook, Me	do	Atlantic, landlocked, and chinook salmon, brook, rainbow, and Scotch sea trout, and hybrids.
Upper Penobscot, Me	Jan.–June	Atlantic salmon.
Duluth, Minn	Entire year	Lake, rainbow, brook, and steelhead trout, whitefish, pike perch, and landlocked salmon.
Grand Marais, Minn	Sept. 25–Dec. 3	Lake trout.
Grand Portage, Minn	Nov. 5–Dec. 2	Do.
Isle Royale, Mich	Oct. 14–Nov. 10	Do.
Keweenaw Point, Mich	Oct. 6–Oct. 22	Do.
Le Claire Point, Minn	July 1–Oct. 5	Sturgeon.
Little Brule, Minn	Nov. 11–Dec. 6	Lake trout.
Marquette, Mich	Oct. 11–Nov. 13	Do.
Munising, Mich	Oct. 14–Nov. 10	Do.
Ontonagon, Mich	do	Do.
Edenton, N. C	Entire year	Shad and black bass.
Weldon, N. C	Mar. 15–May 15	Striped bass.
Erwin, Tenn	Entire year	Rainbow and brook trout, large-mouth and small-mouth black bass, rock bass, sunfish, yellow perch, yellow catfish, and carp.
Gloucester, Mass	do	Cod, pollock, haddock, flatfish, and lobster.
Boston, Mass	Oct. 11–Nov. 15; Apr. 20–June 30	Lobster.
Portsmouth, N. H	May 1–June 30	Do.
Rockport, Mass	Oct. 1–June 30	Lobster, cod, and haddock.
Green Lake, Me	Entire year	Landlocked salmon, brook trout, lake trout, and smelt.
Grand Lake Stream, Me	do	Landlocked salmon and brook trout.
Homer, Minn	do	Rainbow trout, buffalo-fish, catfish, yellow perch, large-mouth and small-mouth black bass, crappie, sunfish, and rock bass.
La Crosse, Wis	do	Buffalo-fish, catfish, yellow perch, large-mouth and small-mouth black bass, crappie, sunfish, and rock bass.
Leadville, Colo	do	Brook, rainbow, and black-spotted trout.
Cheesman Lake, Colo	Apr. 10–May 16	Rainbow trout.
Edith Lake, Colo	Oct. 15–Nov. 20	Brook trout.
Eldora Lake, Colo	Oct. 15–Nov. 18	Do.
Engelbrecht Lake, Colo	Oct. 9–Nov. 16	Do.

FISH-CULTURAL STATIONS OPERATED DURING THE FISCAL YEAR 1913—Continued.

Designation.	Period of operation.	Species handled.
Leadville, Colo.—Continued.		
Miklick Ponds, Colo.	Nov.	Brook trout.
Musgrove Lakes, Colo.	Oct. 10–Dec. 2	Do.
Seven Lakes, Colo.	June 16–July 15	Black-spotted trout.
Smith Ponds, Colo.	Oct. 26–Dec. 6	Brook trout.
Mammoth Spring, Ark.	Entire year	Small-mouth and large-mouth black bass, crappie, catfish, sunfish, and rock bass.
Friars Point, Miss.	May 5–June 30	Large-mouth black bass, catfish, and sunfish.
Marked Tree, Ark.	July 1–Sept. 10	Large-mouth black bass, crappie, sunfish, catfish, pickerel, and buffalo-fish.
Manchester, Iowa	Entire year	Brook and rainbow trout, small-mouth black bass, and rock bass.
Bellevue, Iowa	July 15–Sept. 1; Apr. 1–May 17	Black bass, sunfish, catfish, pike, crappie, and buffalo-fish.
North McGregor, Iowa	July 15–Aug. 1; Apr. 25–May 15	Black bass and catfish.
Nashua, N. H.	Entire year	Brook, rainbow, and steelhead trout, chinook salmon, and small-mouth black bass.
Neosho, Mo.	do	Rainbow trout, large-mouth and small-mouth black bass, rock bass, crappie, sunfish, and carp.
Northville, Mich.	do	Lake, brook, and rainbow trout, small-mouth and large-mouth black bass, crappie, catfish, and yellow perch.
Algonac, Mich.	May 1–May 21	Pike perch.
Au Sable, Mich.	Nov. 5–Nov. 9	Lake trout.
Bay City, Mich.	Mar. 22–May 3	Pike perch and yellow perch.
Belle Isle, Mich.	Oct. 24–Dec. 10	Whitefish.
Charity Island, Mich.	Oct. 9–Nov. 30	Do.
Charlevoix, Mich.	Nov. 5–Nov. 22; Feb. 17–May 10	Lake trout and whitefish.
Cheboygan, Mich.	Oct. 18–Nov. 6	Lake trout.
Detour, Mich.	Oct. 14–Nov. 9	Do.
Detroit, Mich.	Entire year	Whitefish, yellow perch, and pike perch.
Fairport, Mich.	Nov. 1–Nov. 20	Lake trout.
Frankfort, Mich.	Nov. 6–Nov. 20	Do.
Grand Haven, Mich.	Nov. 5–Nov. 20	Do.
Grassy Island, Mich.	Oct. 21–Dec. 7	Whitefish.
Great Lake George, Mich.	Oct. 17–Nov. 16	Do.
Manistique, Mich.	Oct. 28–Nov. 21	Lake trout.
Port Huron, Mich.	May 3–May 17	Pike perch.
St. James, Mich.	Nov. 1–Nov. 22	Lake trout.
St. Joseph, Mich.	Oct. 21–Nov. 20	Do.
Sault Ste. Marie, Mich.	Feb. 15–May 15	Whitefish and lake trout.
Put-in Bay, Ohio	Entire year	Whitefish, pike perch, and yellow perch.
Kellys Island, Ohio	Nov. 12–Dec. 4	Whitefish.
Middle Bass, Ohio	Nov. 18–Dec. 4	Do.
Monroe Piers, Mich.	Nov. 1–Dec. 8 and Apr.	Whitefish and pike perch.
North Bass, Ohio	Nov. 12–Dec. 7; Apr. 17–May 8	Whitefish, pike perch, and yellow perch.
Port Clinton, Ohio	Nov. 10–Dec. 7; Apr. 8–Apr. 29	Whitefish and pike perch.
Toledo, Ohio	Apr. 7–Apr. 30	Pike perch.
Quincy, Ill.	Entire year	Large-mouth and small-mouth black bass, rock bass, pike perch, yellow perch, sunfish, catfish, crappie, buffalo-fish, and carp.
St. Johnsbury, Vt.	do	Brook, rainbow, and steelhead trout, silver and landlocked salmon, and small-mouth black bass.
Darling Pond, Vt.	July 19–Dec. 6	Brook trout.
Holden, Vt.	Entire year	Brook and steelhead trout.
Lake Mitchell, Vt.	Sept. 4–Nov. 30	Brook trout.
Lake Wantastiquet, Vt.	Sept. 16–Dec. 4	Do.
Orleans, Vt.	Apr. 16–May 16	Steelhead trout.
Swanton, Vt.	Mar. 12–May 23	Pike perch and yellow perch.
San Marcos, Tex.	Entire year	Black bass, rock bass, crappie, and sunfish.
Spearfish, S. Dak.	do	Brook, Loch Leven, rainbow, black-spotted, lake, and steelhead trout.
Schmidt Lakes, S. Dak.	Oct. 20–Dec. 20	Brook trout.
Sand Creek, S. Dak.	Oct. 20–Jan. 15	Do.
Tupelo, Miss.	Entire year	Large-mouth black bass, rock bass, sunfish, warmouth bass, crappie, catfish, and yellow perch.
Rosedale, Miss.	July–Dec.	Large-mouth black bass, rock bass, yellow bass, crappie, sunfish, catfish, and white bass.

FISH-CULTURAL STATIONS OPERATED DURING THE FISCAL YEAR 1913—Continued.

Designation.	Period of operation.	Species handled.
White Sulphur Springs, W. Va.	Entire year	Brook, rainbow, and blackspotted trout, small-mouth and large-mouth black bass.
Woods Hole, Mass.	do	Cod and flatfish.
Noank, Conn.	Mar. 8–Mar. 25	Flatfish.
Plymouth, Mass.	Nov. 19–Mar. 25	Cod.
Sagamore, Mass.	do	Do.
Waquoit, Mass.	Jan. 13–Mar. 25	Flatfish.
Wickford, R. I.	Feb. 19–Mar. 25	Do.
Wytheville, Va.	Entire year	Brook and rainbow trout, large-mouth and small-mouth black bass, rock bass, and sunfish.
Yes Bay, Alaska	do	Blueback salmon.

FISH-CULTURAL RELATIONS WITH THE STATES AND WITH FOREIGN COUNTRIES.

The Bureau has continued and extended its cooperative relations with the State fishery authorities, and in 1913 allotted large numbers of eggs to be hatched under State auspices and considerable numbers of young fish, for planting in local waters. The States which requested this kind of aid from the Bureau number 25 and include nearly all that are engaged in practical fish culture. A list of the States, and the allotments to each, is shown in the following table:

ALLOTMENTS OF FISH AND FISH EGGS TO STATE FISH COMMISSIONS IN THE FISCAL YEAR 1913.

State and species.	Eggs.	Fry.	Fingerlings, yearlings, and adults.
California:			
Brook trout	150,000		
Chinook salmon	16,942,873		
Grayling	50,000		
Landlocked salmon	10,000		
Colorado: Blackspotted trout	2,000,000		
Connecticut:			
Brook trout	25,000		
Lake trout	50,000		
Yellow perch	5,000,000		
Delaware: Black bass			150
Georgia:			
Black bass			2,500
Sunfish			700
Idaho: Brook trout			1,650
Maine:			
Brook trout	100,000		
Landlocked salmon	100,000		
Maryland: Black bass			600
Massachusetts:			
Catfish			300
Chinook salmon	50,000		
Pike perch	4,000,000		
White perch	15,000,000		
Yellow perch	5,000,000		
Michigan:			
Grayling	50,000		
Lake trout	3,000,000		
Pike perch	41,700,000		
Yellow perch		3,500,000	
Minnesota:			
Lake trout	500,000		
Landlocked salmon	10,000		
Steelhead trout	100,000		
Missouri: Rainbow trout			37,800

ALLOTMENTS OF FISH AND FISH EGGS TO STATE FISH COMMISSIONS IN THE FISCAL YEAR 1913—Continued.

State and species.	Eggs.	Fry.	Fingerlings, yearlings, and adults.
Montana:			
Blackspotted trout	2,038,500		
Brook trout	200,000		
Grayling	588,000		
Rainbow trout	50,000		
Whitefish	3,000,000		
Nevada:			
Brook trout	50,000		
Rainbow trout	50,000		
Silver salmon	100,000		
New Hampshire:			
Chinook salmon			7,900
Steelhead trout	75,000		
New Jersey:			
Landlocked salmon	8,000		
Rainbow trout	50,000		
Steelhead trout	100,000		
White perch		2,000,000	
Yellow perch		2,000,000	
North Dakota: Steelhead trout	200,000		
Ohio: Whitefish	19,280,000		
Oregon:			
Blackspotted trout	625,000		
Blueback salmon	2,000,000		
Brook trout	300,000		
Chinook salmon	21,491,000		
Rainbow trout	380,000		
Pennsylvania:			
Lake trout	100,000		
Whitefish	40,920,000		
Utah:			
Brook trout			12,000
Catfish			72
Small-mouth black bass			160
Vermont:			
Brook trout		50,000	
Lake trout	150,000		
Landlocked salmon	10,000		
Steelhead trout	30,000		
Washington:			
Blackspotted trout	400,000		
Steelhead trout	200,000		
Wisconsin:			
Lake trout	2,500,000		
Whitefish	5,000,000		
Wyoming:			
Black bass			60
Blackspotted trout	2,200,000		
Brook trout	225,000		560
Grayling	50,000		
Lake trout	50,000		2,000
Rainbow trout	148,000		
Steelhead trout	100,000		
Total	196,506,373	7,550,000	66,452

In response to requests coming through diplomatic channels, in return for courtesies received, the Bureau furnished the following numbers of eyed eggs to the authorities of the countries indicated:

SHIPMENT OF EGGS TO FOREIGN COUNTRIES DURING THE FISCAL YEAR 1913.

Country.	Species.	Number.
British Columbia	Whitefish	5,000,000
Canada	Brook trout	150,000
	Steelhead trout	100,000
Germany	Rainbow trout	100,000
India	do	10,000
Japan	do	250,000
Total		5,610,000

REVIEW OF FISH-CULTURAL OPERATIONS.

Pacific coast and Alaska stations.—No improvement has occurred in the conditions which have prevailed for some years in the Sacramento River and tributaries, resulting in a general decline of the salmon runs, and a relative falling off in the output of the Bureau's California stations. A large run of salmon was reported in the Sacramento River in the fall of 1912, but owing to extremely low water during the spawning season comparatively few of the fish were able to enter the tributaries on which the hatcheries are located. Later on, unusually heavy freshets partly wrecked the retaining racks and permitted the impounded fish to escape. An attempt was made late in the fall to secure eggs from commercial fishermen operating in the Sacramento River, near Tehama, Cal., but no ripe fish were found, and the fishermen abandoned the work early on account of the low market value of their catch. The entire collection of chinook salmon eggs for the Baird, Battle Creek, and Mill Creek stations amounted to 20,111,800. Low-water stages also existed throughout the season in Cottonwood Creek, at Hornbrook, Cal., and in the Klamath River, at Klamathon, Cal., reducing the collections of rainbow trout and silver salmon eggs at these points below those of the preceding year.

Increased efforts and the generally favorable climatic conditions prevailing in Oregon resulted in substantial gains in the output of fish from the stations in that State. There was an unusually heavy run of chinook salmon in the Columbia River and tributaries, continuing from early in September until late in the fall. On the Little White Salmon River 30,595,000 eggs were secured, filling the hatchery to its capacity and necessitating the transfer of large numbers of eggs to other stations to relieve the congested condition. The collections at the Big White Salmon station were supplemented by eggs derived from brood fish purchased of trap fishermen operating in the Columbia River, the fish thus obtained being towed to the station and held in a small stream on the reservation for the ripening of their eggs. The output of salmon fry at the two Columbia River stations was the largest in their history. The egg collections on the Little White Salmon exceeded those of any previous year by 12,000,000, and when the work was discontinued on October 7, owing to lack of hatching facilities, ripe salmon were still available.

The same conditions governing the run of salmon in the Columbia River existed in other streams in Oregon, and resulted in an increased output of silver salmon and steelhead trout. The Cazadero field station, on the upper Clackamas River, having been cut off from the free passage of fish by the recent construction of an 80-foot dam, a new site for the conduct of operations was selected at a point on

the river 30 miles distant from Portland, the land for the purpose and the water supply for the hatchery being donated to the Bureau by the Portland Railway, Light & Power Co.

The year's fish-cultural operations at Baker Lake and auxiliary stations, in Washington, were attended with gratifying results, the output of chinook, blueback, silver and dog salmons, and steelhead trout being substantially larger than in either of the two previous years. The total egg collections of all species numbered 46,330,500, as compared with an aggregate of 23,535,800 in 1912, and the output of fry was correspondingly increased. At the other Puget Sound stations there was a slight falling off in the output of silver salmon, owing to the destruction of the retaining racks by freshets during the spawning season, but the losses were more than offset by the collections at two new field stations established and operated for the first time on Elwell Creek, near Sultan, and on the Sauk River, near Darrington. A new station was also operated on the Dusenwallops River, a tributary of Hood Canal, Puget Sound, near Brinnon, Wash., where 8,360,000 dog salmon eggs were gathered. The work of the Baker Lake station, which is located in an almost inaccessible region on Baker Lake, at the foot of Mount Baker, was greatly facilitated by the establishment of a telephone line connecting the station with Concrete, Wash., the nearest railroad station, 18 miles distant. The Birdsview station, on the Skagit River, was improved by the erection of new hatchery and other buildings.

The eruption of Katmai Volcano, on the Alaska peninsula, June 6, 1912, covered the island of Afognak with volcanic ash and sand to an average depth of 9 inches. It is estimated that 20,000 salmon perished at the head of Litnik Lake, while thousands ascending tributary streams during the spawning season in July were driven back into the ocean. These conditions curtailed the work of the Afognak station, the total output for the year 1913 amounting to 12,551,102 blueback and 151,800 humpback salmon fry. Owing to the accumulation of volcanic ash in the hatching troughs, great difficulty was experienced in holding the comparatively small number of eggs collected, and heavy losses of both eggs and fry resulted through suffocation. In May, 1913, two temporary field stations were located in connection with the Afognak station—one on a small stream tributary to Eagle Harbor and one at Uganak Lake, Kodiak Island. Racks were constructed and the salmon runs were investigated with the view of ascertaining if the conditions warrant the establishment of permanent stations in these fields.

At the Yes Bay, Alaska, station there was a slight shortage in the collection of blueback salmon eggs, owing to low-water stages early in the season, followed later by heavy rains and freshets, which partly destroyed the retaining racks and allowed the escape of several

thousand ripe fish. During the early part of the season the eggs collected were of poor quality, owing, it is supposed, to the low water which caused the fish to remain in the lake too long after their eggs matured. The eggs improved in quality as the season advanced, the operations resulting in a total yield of 66,125,000, a shortage of 5,875,000 as compared with the take of last year. Many improvements were made to the buildings and apparatus during the year, the most important of which was the installation and operation of 160 additional hatching troughs.

The condition of the salmon fisheries of the Pacific coast warrants continuous and systematic investigation and makes imperative the greatest possible exertions on the part of the Bureau to propagate the various salmons on a more extensive scale and to distribute the young fish in a manner which will insure the largest results. The superintendent of the California stations reports that a large percentage of the young salmon liberated in the Sacramento River perish on the lowlands, because of irrigating ditches and overflows or easements of the river. The subject has been forcefully treated in various reports from the Bureau's representatives and demands the serious attention of the State authorities. Another feature of the salmon situation in California which may necessitate a complete change in the method of planting is the enormous destruction caused by trout and other predaceous fishes while the young are on their way to the sea.

Better conditions obtain in the States of Oregon and Washington. The irrigation of arid lands is not practiced so extensively as in California, and most of the hatcheries are located nearer tidewater, thereby lessening the loss of young salmon by attacks of predaceous fishes during passage to the sea. Extensive field operations were conducted in Oregon and Washington during 1913, and plans have been made for still greater expansion of the work during the next fiscal year. In the Columbia basin, investigations are now being made, with the view of establishing a station at Swan Falls, Idaho, for the propagation of the early run of chinook salmon.

The results this year at the Quilcene and Duckabush stations, which were operated for the first time in 1912, indicate that the establishment of inexpensive egg-collecting camps on streams tributary to Hood Canal will result in good returns of silver and dog salmon. An additional station on the Sauk River, at Darrington, Wash., plans for which are now being drawn, will add materially to the output of salmon from the Washington stations.

In view of the accepted belief that the salmon fisheries can be more effectively aided and maintained through the liberation of fingerling fish, arrangements have been made to increase the facilities at all the Pacific coast stations, including those in Alaska, for the purpose of

rearing a larger number of salmon fry to the fingerling stage than ever before.

Commercial fishes of the Great Lakes.—The extensive and long-continued operations of the Bureau in the Great Lakes are addressed to the lake trout, whitefish, cisco or lake herring, and pike perch. In addition to the stations belonging to the Government, several hatcheries, abandoned by the State of Michigan for a number of years because of the discontinuance of work of this character, were leased by the Bureau and operated with temporary personnel.

The most important fish-cultural work of the Duluth, Minn., station—the maintenance of the lake trout fisheries of Lake Superior—was slightly interfered with by storms occurring at the height of the spawning season, which not only reduced the egg collections considerably below what had been anticipated, but also impaired to some extent the quality of the eggs secured. The spawning season in the various fields of this lake extended from September 25 to December 6, and resulted in the collection of 10,035,000 eggs, which stock was augmented by the transfer of 5,000,000 green eggs from the Manistique field, a subsidiary of the Northville station. The output of lake trout from Duluth consisted of 1,260,000 eyed eggs, for the stocking of various Government, State, and private hatcheries, and 6,825,000 fry and fingerling fish, for liberation on the spawning grounds in Lake Superior. Additional transfers of eggs of commercial species from other stations to Duluth comprised 20,000,000 whitefish eggs from Put-in Bay station and 25,000,000 pike-perch eggs from Detroit, which were hatched and distributed with only normal losses, the whitefish being deposited in Lake Superior and the pike perch utilized in filling applications for the stocking of various inland lakes in Minnesota and adjacent States.

In the fields operated from the Michigan stations the spawning season of the lake trout opened October 21, a week later than usual, and was just at its height at the beginning of the close season on November 20, when under the State law it became necessary to suspend operations. The collections of eggs at all points numbered 53,907,500, and had the open season been extended a week it is estimated that many million more eggs might have been secured. Approximately 14,000,000 eggs were utilized in stocking various Government and State hatcheries, and 13,500,000 fry were hatched and returned to the spawning grounds in Lakes Michigan and Huron. The whitefish spawning season in Michigan waters extended over a period of two months from October 9, the largest egg collections being obtained from the Detroit River fields, where fishing was conducted under the auspices of the State game, fish, and forestry warden's department. Extensive collections of eggs were made also at Charity Island, in Saginaw Bay, the brood fish being secured from pound

nets operated by a fisherman under a special contract. Work in this field was brought to a sudden close at the height of the season by a disastrous windstorm, which put every net out of commission.

An experimental whitefish collecting station, operated for the first time in the American waters of upper Lake St. George, gave unsatisfactory results, as most of the fish were taken illegally by natives in the vicinity. The work of collecting pike-perch eggs for the Detroit hatchery was conducted from April 9 to May 21 in Saginaw Bay and the Canadian waters of the St. Clair River, 216,550,000 being obtained from fields which had yielded only 21,000,000 eggs in the spring of 1912.

The whitefish spawning season in Lake Erie, extending from November 12 to December 10, was not interfered with to any extent by storms, and the work accomplished was the most successful in the history of the Put-in Bay station, 350,080,000 eggs of good quality being secured from fields which yielded only 82,000,000 in 1912. An encouraging feature of the work was the interest displayed in it by many of the commercial fishermen, to whose assistance a considerable measure of the success may be attributed. Approximately 111,000,000 of the eggs secured were transferred in the green or eyed state to Government and State hatcheries, and 197,300,000 strong, healthy fry were hatched from the remainder and liberated in Lake Erie. The pike-perch work, on the other hand, proved very disappointing, especially in view of the encouraging prospects early in the spring, when brood fish were on the spawning grounds in the lake in large numbers. The prevalence of violent winds prevented the installation of the fishermen's nets for a month beyond the usual time, and before they could be operated to any extent most of the fishes had been driven from the grounds by the immense quantities of mud and filth discharged into the lake as a result of one of the heaviest floods ever experienced. The entire crop of eggs, amounting to 133,500,000, was developed at the Put-in Bay station, and the 46,500,000 fry produced were returned to the lake, no shipments of either eggs or fry being sent to other hatcheries.

No cisco work was attempted by the Bureau in Lake Erie, as arrangements for covering all available territory for the collection of eggs of that species had been made by the Ohio Fish Commission. The propagation of yellow perch and sauger, instituted in connection with the work of the Put-in Bay station in the spring of 1912, was again undertaken, but with poor results. Saugers for some unknown reason were very scarce, and the few eggs secured proved worthless, while the muddy condition of the water supply interfered with the hatching of the yellow-perch eggs to such an extent that only 3,000,000 fry were produced from the 8,064,000 eggs collected.

In Lake Ontario the newly developed fields for the collection of eggs of the whitefish, cisco, lake trout, and pike perch were operated during the respective spawning seasons. Three-Mile Bay and waters in the immediate vicinity of the Cape Vincent station yielded 1,160,000 whitefish and 5,350,000 cisco eggs; 144,160 lake-trout eggs were secured from the Pigeon Island fishery, while 3,937,500 pike-perch eggs of fair quality were obtained in Mud Creek. Far more satisfactory results might have been accomplished in all these fields had not the work been hampered during the entire period of operations by the unfavorable weather and water conditions prevailing. These eggs, together with 40,750,000 eggs of whitefish, lake trout, and pike perch transferred from other stations, were successfully hatched and distributed, most of the fry being liberated in Lake Ontario.

The collections of pike-perch eggs for the Swanton, Vt., station were only about half as large as those of the preceding year, the comparative failure being partially due to the scarcity of female fish on the spawning grounds. Male fish were there in great abundance, and later in the season a consignment of green females was tranferred from the Canadian fishing grounds in the north end of Missisquoi Bay and placed in a rude inclosure which had been provided for them in Lake Champlain, in the vicinity of the field of operations. They were held in good condition so long as a sufficient depth of water could be maintained in the inclosure, but before their eggs had matured in considerable numbers the water in the lake receded and became so warm that, in order to prevent the total loss of the impounded fish, the bulk of them were liberated before they had ripened.

With the view of being nearer the fishing grounds, and also in order that the Bureau might conduct its operations independently of the various persons controlling the river shores heretofore occupied, steps were taken in advance of the spawning season to establish a collecting and penning station on Lake Champlain, at Sandy Point, and while the outcome of the operations was not as favorable as had been anticipated it is believed the change in location prevented what would have otherwise been an almost complete failure, and that the difficulties encountered this season may be largely overcome another year by providing more suitable impounding facilities. The collections numbered 111,037,500, and the output of fry was 58,280,000. In connection with the pike-perch work, 23,300,000 eggs of the yellow perch were secured, 11,000,000 of which were utilized in filling applications from State fish commissions. The remainder were hatched and the fry returned to the spawning grounds.

Reports as to the abundance of the Lake Champlain whitefish in the vicinity of the Swanton station having led to the belief that there was a possibility of satisfactory results in the artificial propagation

of this species, steps were taken during the fall of 1912 to impound brood fish in the inclosure at Sandy Point. In the three days immediately preceding the opening of the fishing season several hundred brood fish were captured and penned, and throughout the open season all the seines within reach of the station were regularly visited by spawn takers, but in no instance was a ripe female secured. From the experience gained the conclusion has been reached that the spawning of the Lake Champlain whitefish occurs after the formation of ice in the lake, at a time when spawn-taking operations could not be successfully conducted.

The marine stations.—The Boothbay Harbor station, in cooperation with the fishery authorities of the State of Maine, collected during the year 16,965 egg-bearing lobsters, constituting the largest brood stock ever secured for the pound established in connection with that station. This stock was carried through the winter with only nominal losses, but the egg collections fell behind those of the preceding year, owing partly to the smaller average size of the lobsters and partly to the unusually large percentage of barren ones. This latter condition was brought about, it is believed, by the abnormally mild winter, which caused many of the lobsters to lose their eggs in the pound. The impounded lobsters yielded 161,064,000 eggs, an average of 12,122 per lobster. The loss on the eggs during incubation was insignificant, and the resulting fry were liberated in excellent condition.

An unusually large body of haddock made its appearance on the Maine coast near the Boothbay Harbor station about the middle of April and afforded excellent fishing for a month. During this period approximately 100,000,000 eggs were secured from the gill-net fishermen and transferred to the station, but the losses during incubation—always heavy on eggs of this species—reduced the stock to such an extent that only 22,967,000 fry were produced.

In marked contrast to the abundance of haddock was the great scarcity of flatfish during the spawning season, not only in fields contiguous to the Boothbay Harbor station, but in all waters along the Maine coast where they are usually found. The diligent operation of fyke nets at all likely points within reach of the station throughout the spawning season, extending from February 25 to the last week in April, resulted in a collection of only 4,007 breeders. Part of this stock was allowed to spawn naturally in the retaining tables, in accordance with past custom, but, owing to lack of room, many of the fish were stripped and the eggs fertilized artificially. The 452,386,000 eggs obtained produced 413,961,000 fry, the loss in hatching amounting to only about 9 per cent, as compared with 12 per cent the preceding year. There appears to be a growing sentiment in favor of the flatfish among the commercial fishermen of Maine,

and it is believed the time is approaching when the Bureau will not be compelled, as at present, to rely solely on its own efforts in obtaining brood fish of this species.

Owing to the nonappearance of the usual inshore run of cod along the Maine coast the efforts of the Bureau to secure eggs in Casco Bay and at Cape Elizabeth proved nearly futile. A small run of fish appeared during the spring in the immediate vicinity of the Boothbay Harbor station, and had fishing operations in these waters been conducted with gill nets there is reason to believe that considerable collections of eggs might have been made. Equipped as the fishermen were, however, with short trawl lines, they met with poor results. The egg collections from all points amounted to 9,089,000 and the fry distributed numbered 5,611,000.

The year's work at the Gloucester station involved the handling of 1,431,588,000 eggs of four species of marine fishes and the lobster and the distribution of 825,050,000 fry hatched therefrom. Fish-cultural operations were continued uninterruptedly from November 1 to the close of the fiscal year, and at many times during this period eggs of the various species were received in such quantities that it was impossible to handle them all with the limited facilities available. The surplus eggs were transferred to the Woods Hole station when practicable, but plants of eggs of pollock, cod, and haddock aggregating 198,407,000 were made in the harbor off Gloucester, owing to the lack of hatching facilities at either station.

During the pollock spawning season, extending from November 1 to the end of January, 856,680,000 eggs were collected from fish taken by a fleet of gill-net steamers, and 430,060,000 fry of good quality were hatched and distributed on the natural spawning grounds off Cape Ann.

Eggs of the cod in considerable numbers began coming in immediately after the close of the pollock season, and with the exception of four days, lots were received daily from February 16 to April 7, the total collections amounting to 170,840,000. This noteworthy record is attributed to the mild weather prevailing throughout the spawning period. The eggs were generally of good quality, and in addition to the transfer of 13,096,000, owing to the crowded condition of the hatchery, 105,150,000 fry were produced for distribution along the Massachusetts coast.

Haddock eggs to the number of 135,800,000 were received between March 17 and April 15, at a time when the hatchery was so crowded that only about half of them could be handled with the apparatus available. The 77,932,000 eggs retained yielded 45,290,000 fry.

On account of inability to obtain brood fish in the usual numbers, the results of the flatfish work were only two-thirds as large as in the

previous season. The 580 brood fish handled yielded 253,365,000 eggs, from which 230,070,000 fry were hatched and distributed. Early in the season these eggs were handled in Chester jars, but later, when all jars were needed for the cod and haddock eggs, the flatfish eggs were placed in scrim-covered floating boxes, made of 2 by 3 inch spruce, 5 feet long, 3 feet wide, and 2 feet deep, from 40,000,000 to 50,000,000 eggs to the box, and development proceeded fully as well as in the jars.

On May 1 the lobsters which had been carried through the winter in the compartment live-car at the Gloucester station were removed to the hatchery and stripped, 453 survivors of the 636 lobsters originally placed in the car yielding 4,811,000 eggs. The spring collection of lobsters for the Gloucester station was the poorest in years, only 543 breeders being secured. These yielded 8,767,000 eggs, giving a total of 13,578,000 for the season. At the close of the year 3,000,000 of these eggs were still in process of hatching.

The work of the Woods Hole station was confined principally to the propagation of cod and flatfish. In November a brood stock of cod was purchased from commercial fishermen and placed in the pool and live-cars to ripen. On November 20 the first consignment of cod eggs was received from the steamer *Phalarope*, operating in the field near Sagamore, Mass., and fair collections were received from that source until Christmas time, when for some reason the fish left the spawning grounds. Slightly more than 45,000,000 eggs were received from the field, and these, added to the yield of the brood stock, gave a total of 216,794,000, from which 110,251,000 fry were hatched and distributed.

Contrary to the conditions experienced at the other marine stations, flatfish were found in abundance in the territory surrounding the Woods Hole station, and the prospects early in the season seemed very promising. It soon transpired, however, that the mild weather, to which was attributed the plentiful supply of brood fish, was having a very detrimental effect upon the eggs, which in the majority of cases failed to develop, the season's collections of 541,114,000 producing only 165,239,000 fry. No lobster work was undertaken at the Woods Hole station the past season, as previous experience had shown that the supply of brood lobsters available on the southern Massachusetts coast was not sufficient to warrant the expense of collecting them. Efforts in this direction will therefore be confined for the present to the Gloucester station.

Anadromous fishes of the Atlantic coastal streams.—The fish-cultural season on the Susquehanna River was marked by peculiar conditions, high winds and correspondingly high or low tides being prevalent most of the time and interfering greatly with the operations of the fishermen. Yellow-perch eggs were received at Battery station daily

from March 17 to March 22, when a heavy southwest storm arose, accompanied by rising temperature, and before its subsidence the spawning season of yellow perch had ended. The egg collections amounted to 286,325,000, and the output of fry to 229,060,000. Collections of white-perch eggs were begun April 8 and discontinued May 20, the 573,000,000 obtained yielding 372,450,000 fry, in addition to 20,000,000 eyed eggs shipped to applicants.

The collections of shad eggs for the Battery station extended from April 19 to May 20 and numbered only 6,861,000, as compared with a take of 12,175,000 in 1912. In addition to the growing scarcity of shad in this river, a most discouraging feature of the shad work is the constantly increasing number of set nets operated by commercial fishermen. The use of these permits destruction by eels of most of the eggs contained in fish taken, owing to the time that elapses between the capture and the tending of the nets.

On the Potomac River some difficulty was experienced in the yellow-perch work by the mild open winter, which permitted extended operations by the commercial fishermen and depleted the supply of brood fish to such an extent that it was impossible to secure a sufficiently large stock of breeders to fill the Bryan Point hatchery with eggs. The collections were made between February 21 and March 14, and resulted in obtaining 10,301 brood fish, about half the number desired. The spawning of these fish was completed by March 24, the total yield of eggs amounting to 124,800,000, an average of 12,115 per fish. A consignment of 3,900,000 eyed eggs was transferred to Central station, and the remaining stock produced 113,923,000 healthy fry, which were distributed in the tributaries of the Potomac River from Broad Creek, Md., to Occoquan Creek, Va.

A new feature of the shad work on the Potomac River was the conversion of a large scow into an auxiliary hatchery, capable of carrying 3,000,000 eggs, by installing thereon a table of 32 McDonald jars and a gasoline pumping plant of a capacity of 2,000 gallons per minute. The water for this hatchery was pumped into a 50-gallon barrel elevated 3 feet above the hatching table, and the connections were arranged for a gravity flow of water to the jars. The scow, thus fitted up and provided with a force of two experienced shad culturists, was moored in Occoquan Bay, Va., for the purpose of promptly and properly caring for all eggs that might be secured within a 24-hour period from the gill-net fishermen operating in that vicinity, such collections being transferred to the main hatchery every night by the steamer *Phalarope*. The provision of this subsidiary hatchery will be the means of saving large numbers of eggs that would otherwise be lost through failure to give them attention as soon as taken, the location in question being too far distant from

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the Bryan Point hatchery to permit of frequent transfers of eggs by messenger.

The shad spawning season opened April 12 and extended to May 17, by which time the shad run had ceased. The egg collections, amounting to 30,919,000, produced 28,428,000 excellent fry, which were carefully distributed over the spawning grounds in the Potomac River. The high percentage of hatch was due to the holding of all eggs delivered at the station for 48 hours before measuring them, and returns to the fishermen were made on the basis of that measurement.

In Albemarle Sound and the contiguous waters seaward, shad were more plentiful than for many years. The mild winter caused spawning fish to make their appearance in the sections operated from the Edenton station somewhat earlier than usual, the first eggs being secured March 20. Five days later the receipts of eggs at the station had become so enormous as to tax the hatching facilities, and shortly afterward the superintendent was compelled to discontinue collections for several days to relieve the congested condition. In the course of the spawning season, which lasted 46 days, there were three additional periods when eggs came in faster than they could be cared for, and on this account many eggs were lost. The season's collections amounted to 138,912,000, and had it not been for the limited hatching facilities they might have been at least 30 per cent greater. The output of fry amounted to 92,522,000, an increase of 20 per cent over that of the preceding year.

The propagation of white perch at the Edenton station having been decided on, three trips were made during March by spawn takers, with collecting outfit, to the spawning grounds of the species, about 20 miles below the station in Albemarle Sound. Practically no fish were secured, and from the information gained it was concluded that the spawning season would not occur until sometime in April, at which time the station force was fully occupied with the shad work. An attempt to propagate the hickory shad at the Edenton station also proved futile, owing to inability to secure the cooperation of the commercial fishermen.

In advance of the spawning season of the striped bass on the Roanoke River it became necessary to renew the hatchery and boiler house, the old plant having been carried away during a 45-foot rise in the river in March. The new hatchery, consisting of a 48 by 16 foot floor built on elevated timbers, and securely wired and anchored to the ground, with the view of resisting future floods, was completed and ready for the reception of eggs by the opening of the spawning season, April 25. The ideal fishing conditions—a series of small swells in the river, serving to keep the water roily so that the fish can not see and avoid the nets—were entirely absent during the season.

No rise of any consequence occurred after April 12, and while striped bass in unusual numbers were in evidence, the returns to the commercial fishermen were the smallest ever known. Notwithstanding the unfavorable weather conditions, more eggs were secured than last year, and the output of fry was greater than in any previous season. The comparative success is attributable in some measure to the proportionately larger number of ripe males secured, and also to the fact that more females in spawning condition were available than heretofore, both these propitious features being made possible by the very conditions which militated against successful fishing operations. Male and female fish, clustered together in the act of spawning, were easily distinguishable in the clear water of the river, and owing to its low stage it was comparatively easy to surround with a net and capture fish so clustered. By means of the motor launch recently provided for the work on this river, the eggs were collected from the commercial fishermen with greater facility than ever before, and to this fact may be attributed the higher percentage of hatch attained. The egg collections numbered 10,383,000, and the output of fry aggregated 7,234,000.

Propagation of the trouts and pond fishes.—At the trout stations of the Bureau the work in general was similar to that of preceding years. The supply of brook-trout eggs derived from brood fish carried in ponds and collected from wild stock was supplemented by the purchase of eggs from commercial dealers, this course having proved more economical for some stations than the collection of eggs from waters available for the purpose. The total output of fry and fingerling trout exceeded that of last year. Owing to unfavorable weather conditions during the spawning season, fewer rainbow trout were produced than in 1912, the falling off in this branch of the work being more noticeable in Colorado than elsewhere.

In the Yellowstone National Park the provision of additional facilities, the establishment of new field stations, and the extension of operations over a wider territory permitted the collection of approximately 29,000,000 blackspotted trout eggs, more than the number secured in that field in any previous year. The fish-cultural possibilities of Yellowstone Lake and tributary streams are practically unlimited and plans will be made another year to increase still further the output of blackspotted trout from this field, which at the present time is the Bureau's only source of supply for eggs of *Salmo lewisi*, one of the most important species of trout.

A new branch of fish culture undertaken in connection with the work of the St. Johnsbury station was the propagation of steelhead trout in streams tributary to Lake Memphremagog. By means of a trap installed in the Willoughby River, brood fish were intercepted and penned in a spring-fed stream entering the river just above the

trap. Operations at this point extended from April 16 to May 16 and resulted in the collection of 176,305 eggs, which were taken by the trap attendant from time to time as the fish ripened, and transferred in fruit jars by express to the St. Johnsbury station. From the experience gained it is believed this will prove a valuable source for egg collections of that species. It was noted that the eggs and fry were much smaller than those of the steelhead trout of the Pacific coast, resembling more closely the eggs and fry of the domesticated rainbow trout. The propagation of steelhead trout from eggs derived from tributaries of Lake Superior, inaugurated in the spring of 1912, could not be resumed the past season, as the waters during the spawning period were too high to permit of successful seining operations. Work in this direction at the Duluth station was therefore limited to the hatching of 50,000 eggs transferred from the Pacific coast, the resulting fry being liberated in June in the streams where this excellent species has established itself.

In connection with the acclimatization of the steelhead trout in the Great Lakes region, reference to which has been made in previous reports, the following information from a Wisconsin correspondent is of interest:

About 1906 several pound-net fishermen in the vicinity of Sheboygan and Port Washington, Wis., caught from 100 to 300 steelhead trout, averaging about 1 pound in weight, most of them being returned to the water. Within the next few years these fish increased in numbers and in size, and at the present time they form an important item in the shipments of all pound-net fishermen on Lake Michigan. In 1912 figures obtained from fishermen between Port Washington and Sheboygan showed the catch for that year to be in the neighborhood of 7,000 and 8,000 pounds, and the catch for 1913 promises to be heavier. The largest specimens taken in the vicinity weighed 22 pounds, but the average weight is 7 pounds. Compared with the lake trout the steelheads have less entrails, are more game, and are found nearer the shore. Many have been caught going upstream. About two-thirds of those caught are spawners, some of them being so weak at spawning time as to be easily caught, giving the impression that they die after spawning. Most of the fish are taken in pound nets and trap nets, in from 1 to 12 fathoms of water. They are not as good "leaders" as lake trout, and will often gill themselves in the nets, or jump high into the air in an effort to escape. The meat of the steelhead resembles very much that of the Pacific coast salmon, except that it is not quite so red. The market price is the same as for the lake trout. Its food consists of lake chubs and lake herring, of which there is such an abundant supply as to be no hindrance to the future increase of these fish.

The experience with the Scotch sea trout at the Craig Brook, Me., station has demonstrated that the species is worthy of extended efforts to propagate and disseminate it. There are now on hand at that station 16 lots of these fish, ranging from fry to specimens 6 years old, all of which originated from one lot of eggs shipped from England in 1891. They have succeeded excellently in the fresh water of the station and have been found to be almost immune to attacks of the troublesome thyroid disease.

In the spring of 1913 a very promising field for the collection of grayling and rainbow trout eggs was opened in Madison Valley, Mont., and operated as an auxiliary of the Bozeman station. During the spawning season, extending through the month of April and the first half of May, 2,445,800 grayling eggs and about 260,000 rainbow-trout eggs were secured near the towns of Ennis and McAllister, Mont. If the conditions for the propagation of grayling in this field prove as favorable as the prospects now indicate, it is the intention to abandon the old grayling station at Red Rock, Mont., which, owing to its almost inaccessible location, is very expensive to operate.

The propagation of the blackspotted trout at Derby Dam, on the Truckee River, was not undertaken the past season, in view of the small numbers of trout ascending to the dam as a consequence of the great diversion of water from the river for agricultural purposes. The work on this river will not be resumed until a more favorable location for a field station can be found.

Taken as a whole the work at the pond stations during the year was satisfactory, the increase in the output of the black basses, sunfishes, and catfishes being due to the adoption of improved methods, and a more comprehensive knowledge of the factors governing the successful propagation of these fishes. While sudden changes in water temperature during the spawning season at some of the northern and western stations curtailed the work somewhat, the output of the southern stations was materially increased over that of last year.

Rescue of food fishes from overflowed waters.—This is regarded as one of the most important and immediately effective branches of the Bureau's work in the conservation of fishery resources, as it means the saving of hundreds of thousands of valuable food fishes which would otherwise be lost.

On the Mississippi and Illinois Rivers there was varying success in the different fields. Protracted drought and consequent low-water stages interfered with the work on the upper and lower Mississippi River, but operations were conducted under more favorable auspices on the Illinois River, and nearly half a million black bass, crappie, sunfish, catfish, and other river species were rescued from the sloughs and bayous which had been cut off from the main river, and utilized for stocking inland lakes and streams. In addition to this output many thousands of fish taken from waters where they would ultimately have perished from drought or cold were liberated in the main river.

Miscellaneous fish-cultural notes.—The season's operations with the buffalo-fish at Manchester and auxiliary stations were somewhat disappointing, owing to the great difficulty in obtaining ripe fish, and the heavy mortality of the eggs secured, as a result of the low-water temperatures prevailing during most of the spawning season.

The experience of the past two years' operations had led to the conclusion that the spawning of the buffalofish would begin at a water temperature of about 60 degrees, which had occurred during those years about April 25. This year, however, the first spawn was taken on April 18, in a water temperature of 52 degrees, and some eggs were taken each day afterward up to and including April 26, when the water temperature reached 59 degrees. The great irregularity in the development of the brood fish—some days all of them being hard and on others all spent—made it impracticable to send out spawn-takers with the seine boats, and the best that could be done was to meet incoming boats and look over the catch. The 23 fish spawned yielded 5,046,000 eggs, only 80,000 of which hatched. All lots of eggs that were an entire loss died within 48 hours after being taken, large air bubbles collecting on them and causing them to float out of the jars.

At the North McGregor station six ripe fish yielded 500,000 eggs. These were held in a floating box in a water temperature of 60 degrees, in the hope that enough additional eggs could be obtained to warrant their transfer to the Manchester station. The lot looked well up to the seventh day, but eventually the eggs became coated with sediment and all were lost.

The experience thus far gained seems to demonstrate the necessity of warmer water than that available at either Manchester or its substations, and the only apparent way of overcoming the difficulty would be the installation at one of the stations of a small pumping plant, with settling tank and filter, which, in view of the expense involved, seems hardly justifiable.

Evidence of the good results of the present efforts in the artificial propagation and the protection of the lobster appears from the fact that the lobster fishermen along the Maine coast last year had a very successful and remunerative season. Numerous reports have been received to the effect that lobsters are becoming more plentiful, and that the increase is quite general along the coast. The Maine fishermen and also the dealers in that State are unstinted in their praise of the Bureau's work in this direction.

Arrangements have been made to transfer several carloads of live lobsters from the Maine coast for deposit at points in Puget Sound, about the San Juan Islands. These transfers will be continued annually until the feasibility of establishing this valuable crustacean on the Pacific coast has been demonstrated.

The adult lake sturgeon, referred to in the last annual report as being retained in a pen at the mouth of Rainy River, at Le Claire Point, Minn., with the view of gaining information as to the spawning habits of the species, escaped from the inclosure during a period of exceptionally high water early in October. Efforts to overcome the

existing obstacles to the artificial propagation of the sturgeon will be renewed at the first opportunity.

In order to add to the commercial value of the eastern fisheries an attempt will be made to establish the humpback salmon on the Atlantic coast by the annual transfer of large numbers of eggs of that species from the Pacific coast, for development at the New England stations, the resulting fry to be placed in suitable streams in the State of Maine.

BIOLOGICAL INVESTIGATIONS, SURVEYS, AND EXPERIMENTS.

AID TO THE OYSTER INDUSTRY.

The Bureau has continued to devote to the oyster industry as much attention as the facilities and resources provided by Congress will permit. The field, however, is very large and varied, and the Bureau is unable to meet all the legitimate demands that are made on it for expert assistance and advice.

In December, 1912, the steamer *Fish Hawk* was ordered to Matagorda Bay, Tex., for the purpose of conducting a survey of the oyster beds in response to the request of the Fish and Oyster Commission of the State. Inquiries relating to the establishment of a biological station on the Gulf coast of Florida were conducted on the way and the vessel arrived off Lavaca Bay, Tex., early in February.

After consultation with the Texas commissioner and with persons interested in the oyster business it was determined that the survey should be confined to Lavaca Bay as the area of greatest present and prospective commercial importance. The recent triangulation by the United States Coast and Geodetic Survey had been carried to the mouth of this bay, and by the use of this and the recovery of an old point it was possible to extend the triangulation as far as required by means of the sextant. This preliminary work was completed in March, and the examination of the oyster beds commenced immediately. The weather was unusually tempestuous, and practically all the signals were destroyed by a tornado soon after their establishment. Despite the difficulties the work was completed about the middle of May. At the end of the fiscal year the smooth sheets were complete, and the report and chart will be ready for the printer by January 1, 1914.

Investigations and experiments respecting enemies of the oyster which annually cause large losses to the oyster industry have been continued as opportunity offered. During the spring the attention of the Bureau was again called to the prevalence of "green gill" over a large area in Chesapeake Bay. This peculiar condition, in reality harmless both to oysters and those who consume them, on account of popular prejudice has caused heavy loss by completely

destroying the market for the affected oysters. The Bureau had no facilities for immediately investigating the matter, as the only qualified assistant was engaged in the Texas survey previously described, and the trouble had abated by the time he was available, only to grow virulent as soon as he was irrevocably detailed to other work.

The oyster interests of Long Island Sound are urging the study of the starfish and the drill, which annually cause heavy loss to the oyster growers, but the Bureau can not carry on the work continuously and systematically with its present force. These are but instances of the Bureau's failure to provide the assistance asked for by the fisheries, owing to the wholly inadequate personnel allowed it for the purpose.

PROGRESS IN MUSSEL CULTURE.

Marked progress has been made during the year in the cultivation of pearly fresh-water mussels, which are the objects of an extensive fishery and support numerous plants at which buttons are made.

The station at Fairport, Iowa, and the field parties operating in connection therewith have achieved practical results in the propagation of mussels. The work was conducted at 15 localities in the Mississippi Valley, 10 of which were on the Mississippi River. Over 150 million young mussels were planted, of which 57 million were liberated in Lake Pepin, 25 million in the vicinity of Fairport, and the remainder at other places in Iowa and Minnesota, and in Wisconsin, Illinois, Indiana, and Arkansas. As a necessary part of these operations there were handled about 100,000 food and game fishes of various species, of which a large number were rescued from overflowed lands and returned to the rivers. The field explorations were considerably curtailed on account of the embarrassment occasioned by the delay in the passage of the appropriation bill. An examination was made, however, of the mussel resources of the Illinois River, and a reconnoissance of a large number of lakes and streams in Minnesota opened up new fields for mussel culture and suggested new sources of supply of commercial shells.

Investigations in the field and laboratory have resulted in the discovery of the hosts and breeding habits of certain important commercial mussels and promise to result in the propagation of valuable species which previously could not be cultivated because of ignorance of fundamental facts. Research into the causes and phenomena of pearl formation have been continued.

INVESTIGATIONS OF LAKES AND STREAMS.

The investigation of the Illinois River in respect to the effects of the discharge of sewage through the Chicago Drainage Canal were brought to a conclusion during the year and a report thereon has been prepared. This is one of the most important studies of the effects of stream pollution on the fishes and fisheries, and it is believed that the results will be of great value in connection with the solution of problems which are yearly growing more acute. This work was conducted in cooperation with the Illinois Natural History Survey under conditions of great advantage to the Government.

The waters of the Truckee River Basin in California and Nevada have been under investigation at various times during the year. As has been indicated in previous reports of the Bureau, the use of the waters of this system for irrigation purposes has already reached a stage resulting in the destruction of large numbers of valuable food fishes. It appears inevitable that with the growth of the area irrigated the streams eventually will be reduced, in places, to practically dry beds at certain seasons, and the native fishes will become a negligible factor in the food supply. It is possible that a way may be found to compensate for this deficiency by introducing other species of nonmigratory habit which can be acclimatized in the permanent waters, but it is yearly becoming more evident that it will be necessary in some cases to make a frank recognition of the fact that more and cheaper food can be produced by the irrigation of the land than by the conservation of the fishes in the streams. It is the purpose of the present investigation to determine if it be possible to develop the one source of food supply while maintaining the other.

During the summer of 1912 the Bureau continued its examinations of lakes in Washington and Idaho to determine their physical and biological characteristics, particularly as they may affect the culture and acclimatization of fishes. It frequently happens that disappointing results follow the planting of fish in lakes which superficially appear to be admirably adapted to the purpose, and recent investigations have shown that the failures are often due to deficiencies in the physical conditions of the deeper waters. This work is demanded not only for the information of the Bureau in connection with its fish-cultural operations, but has been urgently requested by the State authorities. Similar work has been carried on for several years in Wisconsin in cooperation with the Wisconsin Geological and Natural History Survey. A reconnoissance was also made of a number of lakes in the Superior National Forest Reserve in northeastern Minnesota, which differ much in the character of their fauna from the lakes of more calcareous water farther south.

At the close of the fiscal year investigations were begun on Lake Champlain in cooperation with the State of Vermont, to determine

whether it be possible to establish and maintain a commercial fishery for whitefish without jeopardizing fishing for pleasure and sport, which now yields remunerative business to guides, boatmen, and the keepers of pleasure resorts.

OTHER INVESTIGATIONS AND EXPERIMENTS.

The field work of the biological survey of San Francisco Bay was concluded during the year and considerable progress was made in the study of the collections which have been assigned to various specialists. The general report dealing largely with the economic results of the survey is in an advanced stage of preparation. This investigation was made by the steamer *Albatross* pending the passage of an appropriation for repairs, without which she was unseaworthy and unfit to leave sheltered waters.

During July and August, 1912, the schooner *Grampus* was employed in an investigation of the oceanography of the Gulf of Maine, with the purpose of determining the physical and biological conditions governing the distribution of fish food and young fishes. The work was supplemented during the winter and spring by observations off the coast in the vicinity of Gloucester and on Georges Banks in connection with the otter-trawl investigations.

A related inquiry respecting the spawning of haddock was conducted off the coast of Massachusetts and New Hampshire during the spring, use being made of the facilities afforded by the recently established gill-net fishery for haddock. The spawning grounds of this species, which is extensively propagated by the Bureau, appear to be less restricted than has been generally supposed. The inquiry is to be continued as opportunity is afforded.

Terrapin culture at Beaufort reached a stage which justified the Bureau in issuing a circular descriptive of its methods and commending it as promising commercial returns to persons undertaking it on a practical scale. Considerable interest has been manifested in the project, and experiments are being conducted under private auspices in North Carolina and Florida.

During the spring, experiments in frog culture and in artificial production of the natural food of fishes were begun at the Edenton, N. C., station.

Considerable progress has been made during the year in the accumulation of material toward a series of publications on the life histories of important food fishes and other valuable aquatic animals. This necessarily is slow work and to a very large extent the data are collected as opportunity offers in connection with other investigations. The early larval stages of many American food fishes are unknown, and in order that the breeding grounds and the habitats of the young may be determined it is necessary to collect specimens and make drawings

until a series is completed. This part of the investigation has yielded gratifying results, and there are now on hand several reports on the subject. It is the purpose of the Bureau to have the completed papers cover the points of which understanding is essential for the regulation and protection of the fisheries, and thus to meet a popular demand for information which there is now no means of satisfying.

WORK AT THE BIOLOGICAL LABORATORIES.

The marine laboratories at Woods Hole, Mass., and Beaufort, N. C., were opened at the beginning of the fiscal year, but were operated with considerable embarrassment owing to the inadequacy of the emergency appropriations made available pending the passage of the sundry civil bill. The months of June, July, August, and the first half of September comprise the period of greatest activity in scientific field and laboratory work, owing not only to the clemency of the weather and the greater opportunities afforded for study, but also to the availability at that time of a considerable number of qualified investigators who are occupied in university duties at other seasons.

The inadequacy of the permanent scientific staff of the Bureau makes it necessary to depend for much of its research on temporary assistants who can be engaged only when not engaged in their customary duties. It follows, therefore, that the monthly requirements during the first two months of the year are much in excess of the prorated allowance made by Congress for the purpose of conducting operations until the passage of the regular appropriation. Moreover, it is necessary to arrange for the employment of temporary assistants considerably in advance of the beginning of the fiscal year, not only because the best men will have made other arrangements before the end of June, but also because much of the work must be begun in June or earlier, and continuously prosecuted over the end of the fiscal year in order to produce results warranting the expenditures.

Therefore, unless confidence can be felt that appropriations will be available when due, the laboratory and field work can not be arranged for with proper regard to economy and efficiency, and this was the condition confronting the Bureau at the beginning of the fiscal year. A number of investigators had already reached the laboratories before it became apparent that the appropriations would not be available. Some of these were employed at reduced salaries and others elected to carry on work under the authority possessed by the Bureau to afford facilities to properly qualified investigators.

Under the conditions the work at both Woods Hole and Beaufort was satisfactory, and there were completed a number of researches of practical value, the most important of which related to the habits of fishes and the effects of water pollutions. Further work was conducted on the life history of the oyster drill with a view to finding a

weak point at which this destructive oyster enemy may be attacked. At Beaufort the spawning season of the southern flounder was determined and experiments will be conducted during the next fiscal year to develop the possibility of its propagation at the station.

At the close of the year the permanent laboratory at the Fairport, Iowa, station was ready for occupancy. This station, which combines facilities for fish culture, mussel culture, practical shell testing, and biological and chemical investigations and experiments is designed as a center of a large part of the Bureau's activities in the Mississippi Valley.

DISEASES OF FISHES.

During the year the Bureau has received growing and insistent demands for the investigation of various fish diseases and for the study of the relations of industrial and other contaminations to the fish life in streams. These demands, which have come from Government, State, and private fish-cultural establishments, and from State, municipal, and private interests, are of a character that makes them entirely appropriate for attention at the hands of the Federal fishery service; but, owing to the lack of facilities, the Bureau has been able to do very little to help either itself or the general public in this respect.

The cooperative investigation of cancerous tumors in trout, in which the Bureau has been associated with the New York Laboratory for the Study of Malignant Disease, has been brought to a close by the completion of a report dealing with the cause and nature of the disease and its relation to human health. This but clears the ground for that part of the work which vitally concerns the Bureau, namely, the investigation of the means of preventing and curing the disease in streams and hatcheries. The cooperating institution is not concerned in this phase of the subject and any constructive work in the interests of the fisheries must be conducted by the Bureau.

From every consideration of economy adequate means should be provided for such investigations. At one hatchery alone—Holden, Vt.—over 350,000 trout died from an epidemic in May and June. This was practically the entire stock on hand and the cost to produce these fish, to say nothing of their ultimate value, was greater than would suffice to pay for an assistant qualified to find means of prevention of the losses.

ALASKA FISH AND FUR INDUSTRIES.

SALMON SERVICE.

Details regarding the administration of the salmon and other fisheries of Alaska will be found in a special report issued as a separate document.[a] As complete returns from these fisheries are not obtainable until late fall or early winter of each year, the information here presented is for the calendar year 1912.

For the purpose of enforcing the fishery laws and the regulations made thereunder, there has been the usual inspection of fishing grounds, apparatus, and methods; and information regarding the various branches of the fishing industry has been obtained and appears in the special report.

The laws and regulations have, in general, been well received by the fishing interests, and, with rare exceptions, have been respected throughout Alaska, so far as the field agents of the Bureau have been able to determine. The region is so vast, however, and the facilities so lamentably inadequate for reaching the various fishing localities, many in number and widely separated, that personal inspection in many cases was utterly impossible. Unfortunately this applies more particularly to the fisheries for which there is the greatest need of regular inspection. This fact, together with the limited personnel, and the limited appropriation available for traveling expenses, enables the Bureau at the best to possess no definite knowledge and but scant information regarding a large number of the fishing localities and operations.

The inspection of the canneries, salteries, and hatcheries was more satisfactory. One agent covered the territory from Dixon Entrance on the south to Cordova on the north. Of the 53 canneries operated in that region he visited all but 5 at least once, and most of the salteries and minor establishments; and each of the hatcheries was visited and inspected. Several of the more accessible places were each visited two or three times. In the Bristol Bay region it was not possible to reach all the canneries and fisheries, and only those at or near Nushagak were visited. In central Alaska an agent was able to visit the canneries at the Kusilof and Kenai Rivers, and the inspector kept in close touch with the fishing operations in and about the Afognak reservation during the season.

The season of 1912 was marked by an unusually heavy run of salmon on the south side of Bristol Bay, which resulted in an increase of nearly 40 per cent over the 1911 pack of that region. There was also an unprecedented run of humpback salmon in central Alaska

[a] Alaska Fishery and Fur Industries in 1912, Bureau of Fisheries Document No. 780.

and a large run in Bering Sea. A slight decline in the humpback run occurred in southeast Alaska, where the red salmon practically held their own. There was a shortage of red salmon in the Nushagak region and in central Alaska, which induced an increased pack of the inferior species in those regions.

The Alaska fisheries as a whole were more productive in 1912 than ever before. This was owing largely to the great increase in the catch of the cheaper grades of salmon. The net increase in the salmon catch over 1911 was over 16,963,000 fish. The value of the product of all the fisheries showed an increase over that for 1911 of more than $2,000,000. The aggregate catch of salmon was 60,938,945, from which were prepared 4,056,021 cases of canned salmon valued at $16,295,480, and in addition to these were minor products of the salmon fisheries valued at $837,652. The number of salmon canneries increased from 64 to 87, the majority of the new plants being in southeast Alaska.

In 1911 the five private hatcheries took 167,146,800 red salmon eggs and the two Government hatcheries 102,520,000, making a total of 269,666,800, from which were hatched and liberated 153,868,800 fry by the private and 87,729,700 by the Government hatcheries, a total of 241,598,500. In 1912 the private hatcheries took 86,295,000 red salmon eggs and the Government hatcheries 80,814,470, a total of 167,109,470, which is a decrease of 102,557,330 as compared with 1911.

Under the provision of law exempting from taxation the output of the salmon canneries at the rate of 10 cases of canned salmon for each thousand red or king salmon fry liberated, the companies maintaining private hatcheries were entitled to receive in 1912 rebates on 153,868,800 fry, or $61,744.

The order of the Secretary of Commerce and Labor of December 19, 1907, closing Wood and Nushagak Rivers to salmon fishing, remains in force and no commercial fishing was carried on in those streams. With the cooperation of the companies operating canneries in the Nushagak region, Wood River was again racked in 1912, and a tally was kept of the red salmon ascending that stream to Lake Aleknagik for spawning purposes. The number of fish thus counted was 325,264, as against 354,299 in 1911. The number of salmon caught in the Nushagak region was 3,866,950, an increase of 1,053,313 over that for the previous year. In the five years from 1908 to 1912 the catch in the Nushagak region has decreased 37 per cent, while the number escaping to the spawning beds has decreased 87 per cent. In 1908 the number escaping was 30 per cent of the entire run; in 1912 it was but 7.7 per cent. This indicates a very serious condition if natural propagation alone is to be depended upon to keep up the supply of salmon in that region.

The usual statistical canvass of the Alaska fisheries showed 24,263 persons engaged in the various branches of the industry, $38,263,457 invested, and products valued at $18,877,480.

A feature of the Alaska fisheries is a growing appreciation of the value of products formerly regarded as useless and the equipment of a number of small plants designed to utilize such materials. Only a very small fraction of the multitude of natural aquatic products of Alaska—fishes, mollusks, crustaceans, etc.—has as yet been utilized by man. It is known that many of these possess a high food value, but methods of preparing them as food have not been developed. Of fishes alone there are more than 300 species, of which fewer than a score are as yet utilized by man as food. How many more can be found to possess considerable economic food value remains to be determined, but that the number is large is reasonably certain. Perhaps the most promising is the herring (*Clupea pallasii*), a very abundant fish, at present utilized chiefly in the manufacture of fertilizer and oil, but used to some extent fresh, frozen, or pickled, or as bait in the halibut fishery. A closely related species, the Atlantic herring (*Clupea harengus*), is the fish which supports the largest fishery in the world, also the American sardine and smoked-herring industries, in which a vast amount of money is invested and whose output is worth millions of dollars. There is no inherent reason why the Pacific herring may not be prepared for sardines and in the numerous other ways in which the Atlantic herring is utilized.

The eulachon, the capelin, and the surf smelt, three most delicious fishes, literally swarm in untold numbers in Alaskan waters, but as yet are utilized scarcely at all. The Dolly Varden trout, so abundant as to be a great nuisance and very destructive to salmon spawn, should be studied with reference to its utilization as food. The score or more of surf fishes, rock cods, greenlings, Atka mackerel, sculpins, and sand lances, are all promising species to experiment with. There are also the clams, crabs, and numerous other crustaceans and mollusks, related species of which in other countries support important fisheries, yet nothing is done with them in Alaska.

Under date of November 18, 1912, after a hearing given at Seattle, Wash., on October 18, the Secretary issued an order prohibiting, until further notice, all commercial fishing for salmon (1) in all streams flowing into Cook Inlet, together with their lakes and tributary waters; (2) in Eyak Lake and its tributary waters, except that fishing is permitted, under specified restrictions, in Eyak River below the lake; (3) in Anan or Humpback Creek, its lagoon, lakes, and tributary waters, together with the region within 500 yards of the mouth of the creek; and (4) in Naha Stream, its lagoon, lakes, and tributary waters, above a line connecting Loring Point and House Point. The order became effective January 1, 1913.

By order of the Secretary, dated March 21, the natives of the Afognak reservation were given permission to conduct commercial fishing in the reserved waters under certain restrictions. The business was placed in charge of an inspector, who issued permits to those entitled to receive them, promulgated regulations in accordance with general orders from the Department, kept in daily touch with the fishery, and enforced compliance with the regulations. The total number of licenses issued was 93, of which 7 were to white men. The salmon taken numbered about 175,000 fish, including about 17,000 handled at the hatchery. This catch was somewhat disappointing. The eruption of Katmai Volcano June 6 covered Afognak Island so completely with ashes that fishing was entirely suspended for more than two weeks and was nowhere fully resumed. This no doubt had a serious effect on the catch, which otherwise would in all probability have been much greater. Besides the immediate effects on the fishery there will no doubt be after effects from which the fishery will not recover for some years.

FUR-SEAL SERVICE.

The sealing operations on the Pribilof Islands during the season of 1912 were conducted, as in 1910 and 1911, under the direct control of the fur-seal agents of the Bureau. The treaty of July 7, 1911, which makes pelagic sealing unlawful, went into effect December 15, 1911, and, as a result, there was no pelagic sealing during the season of 1912. This was the first season, therefore, since the beginning of pelagic sealing that the fur-seal herd was not subject to the ravages of the sealing fleet. To this essential protective measure the herd made an immediate response. It was possible for the first time in the history of the fur seal to take an actual census of the herd. An actual count was made of all the active bulls, all the idle and young bulls, all the hauling-ground bulls, all the 3-year-old males marked and reserved for breeders, all the pups, and, by evident deduction, all the cows. The only classes not actually counted were the yearling males and females, the 2-year-old males and females, the unbranded 3-year-old males, and an uncertain number of 4-year-old males, all of which were estimated conservatively at 48,000.

The census of the herd showed seals of the various classes present on the islands as follows:

Active bulls, with harems (actual count)	1,358
Idle and young breeding-ground bulls (actual count)	312
Hauling-ground bulls (actual count)	302
Branded reserve bulls (actual count)	2,000
Pups (actual count)	81,984
Breeding cows (equal to the pups in number)	81,984
Remaining nonbreeding seals (estimate)	48,000
Total	215,940

The census for 1911 was based chiefly on estimates and was evidently an underestimate. Nevertheless, it is believed that there were on the islands in 1912 at least 30,000 seals that would not have been there if pelagic sealing had continued. During the season of 1911 the pelagic sealers took 14,511 skins, according to the report of Messrs. C. M. Lampson & Co., of London. This number included some skins from the Commander Islands herd. It is well known that the pelagic sealers kill many seals they do not recover and that the actual number of skins marketed is far below and probably is less than half the number of seals actually killed. With this exceedingly low estimate it is evident that the loss actually sustained by the Pribilof herd in 1911 could not have been less than 15,000 breeding females; and it is safe to assume that as great a loss would have occurred in 1912 if pelagic sealing had gone on. These 15,000 breeding females thus saved produced 15,000 pups, making 30,000 seals on the islands in 1912 as the immediate response to the cessation of pelagic sealing.

In 1913 a census of the seal herd made under the same conditions as in 1912 and participated in by two or three cooperating agents of the Bureau gave the following result, the number of the pups being accurately determined by actual count after the harems had broken up in August and the equivalent number of breeding females being necessarily present:

Active bulls, with harems (actual count)	1,403
Idle and young bulls (actual count)	364
Bachelors, 1, 2, 3, and 4 years old (count and estimate)	47,000
Cows 1 and 2 years old (count and estimate)	35,000
Breeding cows (equal to pups)	92,269
Pups (actual count)	92,269
Total	268,305

The number of skins shipped in 1912 was 2,880 from St. Paul Island and 884 from St. George Island, a total of 3,764. These, together with 9 skins from the previous season which had been sent to Washington for experimental purposes, were sold at auction in London January 17, 1913, by Messrs. C. M. Lampson & Co., acting as agents for this Government. The net proceeds of the sale were $130,640.57, for which sum a certified check was duly received and covered into the United States Treasury. Under the leasing system which prevailed prior to 1910 the Government would have received only $38,589.25 for the season's take of skins.

The fox skins obtained on the Pribilof Islands in the winter of 1911–12 consisted of 109 blues and 27 whites on St. Paul, and 275 blues and 2 whites on St. George, a total of 384 blues and 29 whites. They were sent to London and sold at auction March 7, 1913, by Messrs. C. M. Lampson & Co., acting as agents for this Government. The net proceeds of the sale were $20,505.17, for which sum a certified

check was duly received and covered into the Treasury. A choice lot of 28 skins from St. Paul Island sold for $131 per skin. Under the old leasing system the Government received nothing for the fox skins.

On June 30, 1913, the positions of agent and three assistant agents, fur-seal fisheries, ceased to exist through failure of Congress to provide for them. The sundry civil appropriation bill for the year 1914 substituted for the foregoing the positions of two agents and caretakers.

MINOR FUR-BEARING ANIMALS.

The warden and four deputy wardens, for which provision was made in the sundry civil bill making appropriations for the fiscal year 1912, spent the entire year in Alaska, establishing headquarters in certain of the more important fur-producing regions where they could keep in touch with the trappers and hunters and see that the law and regulations were observed. A study of the habits of the various species of fur-bearing animals was thus possible, and a large amount of valuable information was obtained. Specimens were also collected for the purpose of making possible a study of the condition of the fur at different seasons in the various fur-producing regions of Alaska. Such specimens are very useful in arriving at decisions as to the proper dates for close seasons in the different parts of Alaska.

The cooperative arrangement made with the governor of Alaska for the purpose of securing a more effective enforcement of the fur and game laws of the Territory has been continued, in part. By this arrangement the warden and the four deputy wardens were to be appointed as special game wardens and five of the Alaska game wardens were to be appointed special fur wardens. In the early part of 1913 the governor found it impracticable to continue longer the services of the special game wardens appointed by him. The Bureau, however, finds it desirable to continue the services of the special fur wardens. They are paid a nominal salary of $10 per month and are invested with the same authority for enforcing the provisions of the law and regulations as are the regular wardens. The scope of territory to be covered makes it necessary to secure the assistance of as many agents as possible.

During the past year three convictions have been had for violation of the act of April 21, 1910, for the protection of the fur-bearing animals in Alaska. The convictions were for violations in widely separated portions of Alaska, and it is believed that they will have a deterrent effect upon those disposed to violate the law.

The regulations issued by the Department have proved satisfactory in most respects and have had a very good influence upon the hunters and trappers who, in the main, are in sympathy with the efforts of

the Government to conserve the fur resources of Alaska. One immediate effect has been a very marked improvement in the quality of furs shipped from the Territory. Several large buyers of Alaska furs state that the improvement has been 25 to 30 per cent. This was due to the fact that the hunters and trappers were more careful to observe the close season and local buyers were less disposed to purchase unprime skins.

As a result of the inquiries made by the warden and the deputy wardens, together with information received from persons interested in the preservation of the fur resources of Alaska, the desirability of revising the regulations promulgated March 8, 1911, was shown. Revised regulations were accordingly drafted and approved by the Secretary under date of March 26, 1913. The principal changes in the new regulations are: (1) The close season on sea otter is extended to November 1, 1920, and that on beaver to November 1, 1918; (2) minor changes are made in the open and close seasons for several of the other fur bearers; (3) the close season on the black bear is removed; and (4) prohibition is placed upon the taking or selling of unprime skins.

The following statement shows by species the number and value of furs shipped from Alaska in the year ending November 15, 1912:

Species.	Number.	Average value.	Total value.
Bear, black	698	$7.50	$5,212.50
Bear, brown	19	9.00	171.00
Bear, glacier	5	15.00	75.00
Bear, polar	9	40.00	360.00
Beaver	89	10.00	890.00
Ermine	7,957	1.36	10,821.52
Fox, black	3	600.00	1,800.00
Fox, blue	502	45.00	22,590.00
Fox, blue, Pribilof Islands	384	56.63	21,708.48
Fox, cross	603	17.00	10,251.00
Fox, red	8,018	8.50	68,153.00
Fox, silver gray	142	250.00	35,500.00
Fox, white	3,108	12.50	38,850.00
Fox, white, Pribilof Islands	29	17.29	501.43
Hare, Arctic	55	.40	22.00
Lynx	2,720	21.50	58,480.00
Marten	12,999	12.50	162,487.50
Muskrat	123,925	.40	49,570.00
Mink	31,363	4.50	141,133.50
Otter, land	1,480	14.00	20,720.00
Otter, sea	1	200.00	200.00
Reindeer, fawn	4	1.00	4.00
Seal, fur	3,764	37.52	141,290.32
Seal, hair	333	1.50	499.50
Squirrel	611	.08	48.88
Wolf	103	9.00	927.00
Wolverine	189	10.00	1,890.00
Total			794,156.63

A number of permits have been issued authorizing the taking and shipping of various fur-bearing animals, principally foxes, for breeding purposes. Applications for permits for such operations became so frequent as to cause concern in regard to the maintenance of the natural supply of wild stock. The Department decided to issue further permits for the shipment of foxes from Alaska only to bona fide owners or operators of fox ranches and to make such permits applicable only to foxes which had been bred and reared on these ranches. It was also decided to discontinue the issuance of permits authorizing the capture in Alaska of any fur-bearing animal during the close season prescribed for the species concerned.

Recently the rearing of foxes for their pelts has attracted a great deal of attention, and public interest has been aroused by the reports of extraordinary prices paid for certain varieties for breeding purposes. To develop the possibilities of fox farming in Alaska the Secretary of Commerce has decided to lease certain islands for the purpose, making announcement to this effect in a widely distributed circular.

COMMERCIAL FISHERIES.

OYSTER INDUSTRY.

In the recent canvass of the oyster industry the statistics for the New England and South Atlantic States covered the season ending in 1910; for the Middle Atlantic States, except Maryland and Virginia, and for the Gulf States they covered 1911; and for Maryland and Virginia and the Pacific Coast States they covered 1912. The total number of persons engaged in the oyster industry of the United States, as shown by the statistics for the various sections of the country, was 67,257; the yearly wages paid, combining the different sections, amounted to $10,876,801; and the investment in vessels, boats, fishing apparatus, shore and accessory property and cash capital, not including the value of oyster grounds or the cash capital for the New England States, was $16,880,032. The output of oysters was 32,988,815 bushels, valued at $15,377,983.

About 46 per cent of the quantity and 65 per cent of the value were from planted grounds, the output in many of the States depending largely—in some of them entirely—upon oyster culture. In the New England States 93 per cent, on the Pacific coast 73 per cent, and in New York 86 per cent of the oyster product is derived from private beds. Virginia ranks first among the States in quantity and New York first in value of oysters produced; while Maryland, ranking second in quantity, is third in value of oyster output. A summary of the oyster product of the United States is given in the following table.

OYSTER PRODUCT OF THE UNITED STATES.

Region.	Private grounds.		Public grounds.		Total.	
	Bushels.	*Value.*	*Bushels.*	*Value.*	*Bushels.*	*Value.*
New England States (1910)	5,549,318	$3,439,450	392,703	$157,584	5,942,021	$3,597,034
Middle Atlantic States (1911–12)	7,090,883	5,204,124	11,815,193	4,059,432	18,906,076	9,263,556
South Atlantic States (1910)	456,194	171,298	1,244,804	192,886	1,700,998	364,184
Gulf States (1911)	2,080,005	634,147	4,146,136	842,819	6,226,141	1,476,966
Pacific Coast States (1912)	157,243	659,430	56,336	16,813	213,579	676,243
Total	15,333,643	10,108,449	17,655,172	5,269,534	32,988,815	15,377,983

The oyster industry of various sections has been presented in detail in previous reports. The only portions of the country that remain to be considered are Maryland, Virginia, and the Pacific Coast States.

Maryland ranks first among the States in the number of persons engaged in the oyster industry, which, in 1912, was 24,287, who received $2,724,641 in wages. The yield of oysters was 5,510,421 bushels, valued at $2,127,759, of which only about 5 per cent, or 280,010 bushels, valued at $149,069, were from planted grounds. The output would probably have been much larger had it not been for a severe freeze lasting for about six weeks, during which time the taking of oysters was practically discontinued. In some localities, especially in Kent and Queen Anne Counties, the oysters were more plentiful and in better condition than for many years. The product was taken chiefly with dredges and tongs. Patent tongs are used in a few localities, mainly at Solomons in Calvert County and at Rock Hall in Kent County; they are employed mostly where the water is too deep for common tongs and dredging is not allowed. The principal oyster centers in the State are Baltimore, Crisfield, Cambridge, St. Michaels, Oxford, Chester, Annapolis, Tilghman, and Whitehaven. Out of a total of 3,769,766 gallons of oysters shucked in the State, 1,447,527 gallons were opened at Baltimore, 686,800 gallons at Crisfield, 612,717 gallons at Cambridge, and the remainder at other localities. Baltimore has also an important oyster-canning industry, which is carried on in connection with the canning of fruit and vegetables. The canned-oyster product amounted to 10,170,608 cans, valued at $775,907.

Virginia ranks next to Maryland in the number of persons engaged in the oyster industry, which was 16,487 in 1912, and the wages paid amounted to $2,112,170. The oyster output was 6,206,098 bushels, valued at $2,286,340, of which 36.38 per cent, or 2,257,873 bushels, valued at $1,128,830, were from planted grounds.

Statistics of the oyster industry of Maryland and Virginia in 1912 are given in detail in the following table.

Oyster Industry of Maryland and Virginia, 1912.

MARYLAND.

Items.	Private areas.		Public areas.		Total.	
	Number.	*Value.*	*Number.*	*Value.*	*Number.*	*Value.*
Persons engaged:						
On vessels fishing	3		4,086		4,089	
On vessels transporting	8		808		816	
In shore or boat fisheries	524		8,930		9,454	
Shoresmen	45		9,883		9,928	
Total	580		23,707		24,287	
Wages paid:						
Dredging		$790		$466,385		$467,175
Tonging		35,068		967,184		1,002,252
Transporting		590		101,197		101,787
Planting and transporting		5,020				5,020
Wholesale trade		4,855		1,143,552		1,148,407
Total		46,323		2,678,318		2,724,641
Vessels, boats, apparatus, and other property:						
Vessels fishing	1	500	771	542,375	772	542,875
Net tonnage	7		7,895		7,902	
Vessels transporting	4	3,000	299	351,125	303	354,125
Net tonnage	35		7,286		7,321	
Gasoline boats	25	8,675	1,324	260,765	1,349	269,440
Sail and row boats	146	4,480	3,203	235,720	3,349	240,200
Apparatus—vessel fisheries—						
Dredges			3,017	34,927	3,017	34,927
Tongs	6	30	73	509	79	539
Apparatus—boat fisheries—						
Dredges	8	60	1,595	14,029	1,603	14,089
Tongs	170	776	9,240	47,516	9,410	48,292
Shore and accessory property		12,215		1,665,985		1,678,200
Cash capital		1,900		795,500		797,400
Total		31,636		3,948,451		3,980,087
Planting operations:						
Oyster grounds owned or leased—acres	[a] 3,445.00	186,525			[a] 3,445.00	186,525
Oyster grounds under culture—acres	2,270.00				2,270.00	
Grounds planted during the year—acres	219.00				219.00	
Materials planted during the year—						
Seed oysters—bushels	68,160	18,416			68,160	18,416
Oyster shells—do	26,350	948			26,350	948
Total		19,364				19,364
Oysters on private areas at the end of the year, bushels	769,785	210,028			769,785	210,028
Products:						
Vessel fisheries—						
With dredges—market oysters—bushels	150	60	1,852,940	830,605	1,853,090	830,665
With tongs—market oysters—bushels	1,150	608	17,430	7,063	18,580	7,671
Total	1,300	668	1,870,370	837,668	1,871,670	838,336
Boat fisheries—						
With dredges—market oysters—bushels	6,050	3,075	446,758	175,618	452,808	178,693
With tongs—						
Market oysters, bushels	272,660	145,326	2,900,333	961,777	3,172,993	1,107,103
Seed oysters, bushels			12,950	3,627	12,950	3,627
Total	278,710	148,401	3,360,041	1,141,022	3,638,751	1,289,423
Grand total	280,010	149,069	5,230,411	1,978,690	5,510,421	2,127,759

[a] Includes 330.50 acres held by tenure other than lease.

Oyster Industry of Maryland and Virginia, 1912—Continued.

MARYLAND—Continued.

Items.	Private areas.		Public areas.		Total.	
Wholesale trade:	*Number.*	*Value.*	*Number.*	*Value.*	*Number.*	*Value.*
Market oysters sold in the shell.....bushels..					136,617	$139,820
Oysters sold opened..galls..					[a]3,769,766	3,588,873
Oysters canned.....cans..					10,170,608	775,907
Oyster shells sold..bushels..					4,893,297	73,128
Crushed oyster shells sold.....tons..					10,000	54,375
Lime from oyster shells, tons.....					3,968	8,070
Total.....						4,640,173
Expenses connected with the wholesale trade.....						872,326

VIRGINIA.

	Number.	*Value.*	*Number.*	*Value.*	*Number.*	*Value.*
Persons engaged:						
On vessels fishing.....	155		509		664	
On vessels transporting....	160		657		817	
Inshore or boat fisheries...	3,624		7,736		11,360	
Shoresmen.....	3,646				3,646	
Total.....	7,585		8,902		16,487	
Wages paid:						
Dredging.....		$49,245		$108,900		$158,145
Tonging.....		188,288		1,013,743		1,202,031
Transporting.....		23,670		75,060		98,730
Planting and transplanting		107,894				107,894
Protecting oysters from natural enemies.....		199				199
Wholesale trade.....		545,171				545,171
Total.....		914,467		1,197,703		2,112,170
Vessels, boats, apparatus, and other property:						
Vessels fishing.....	32	77,450	92	53,125	124	130,575
Net tonnage.....	324		807		1,131	
Vessels transporting.....	84	60,000	454	296,400	538	356,400
Net tonnage.....	1,035		5,065		6,100	
Gasoline boats.....	398	132,510	954	214,145	1,352	346,655
Sail and row boats	1,947	54,203	3,964	217,960	5,911	272,163
Apparatus—vessel fisheries—						
Dredges.....	96	1,735	334	4,040	430	5,775
Tongs.....	2	25	9	65	11	90
Apparatus—boat fisheries—						
Dredges.....	77	825	509	4,722	586	5,547
Tongs.....	2,094	7,847	6,256	27,529	8,350	35,376
Shore and accessory property.....		497,520				497,520
Cash capital.....		528,200				528,200
Total.....		1,360,315		817,986		2,178,301
Planting operations:						
Oyster grounds owned or leased..... .....acres..	[b]59,272.60	767,015			[b]59,272.60	767,015
Oyster grounds under culture.....acres..	25,979.34				25,979.34	
Grounds planted during the year.....acres..	2,671.11				2,671.11	
Materials planted during the year—						
Seed oysters...bush..	1,291,090	266,194			1,291,090	266,194
Oyster shells....do....	743,250	21,897			743,250	21,897
Total.....		288,091				288,091

[a] Exclusive of opened oysters bought from dealers in Virginia.
[b] Includes 2,469.96 acres used for bedding oysters, but does not include oyster grounds held by riparian right.

Oyster Industry of Maryland and Virginia, 1912—Continued.

VIRGINIA—Continued.

Items.	Private areas.		Public areas.		Total.	
	Number.	*Value.*	*Number.*	*Value.*	*Number.*	*Value.*
Planting operations—Contd.						
Expenses connected with planting—						
Planting and transplanting		675				$675
Protecting oysters from natural enemies		366				366
Total		1,041				1,041
Oysters on private areas at the end of the year, bushels	5,872,440	1,899,819			5,872,440	1,899,819
Products:						
Vessel fisheries—						
With dredges—market oysters....bushels	485,639	$230,030	171,795	$60,572	657,434	290,602
With tongs—market oysters.....bushels	1,500	800	6,825	2,600	8,325	3,400
Total	487,139	230,830	178,620	63,172	665,759	294,002
Boat fisheries—						
With dredges—market oysters....bushels	93,600	48,970	216,300	84,715	309,900	133,685
With tongs—						
Market oysters, bushels	1,660,603	842,864	1,769,755	675,974	3,430,358	1,518,838
Seed oysters, bushels	16,531	6,166	1,783,550	333,649	1,800,081	339,815
Total	1,770,734	898,000	3,769,605	1,094,338	5,540,339	1,992,338
Grand total	2,257,873	1,128,830	3,948,225	1,157,510	6,206,098	2,286,340
Wholesale trade:						
Market oysters sold in the shell.....bushels					400,628	278,138
Oysters sold opened..galls					2,347,434	2,181,007
Oysters canned.....cans					134,784	8,356
Oyster shells sold..bush					1,907,488	41,406
Crushed oyster shells sold.....tons					8,400	37,300
Lime from oyster shells, tons					23,627	107,383
Total						2,653,590
Expenses connected with the wholesale trade						257,739

Note.—In Maryland the revenue to the State from leases on oyster grounds, license fees, and other sources, in 1912, was $83,997, and the cost of administration was $117,949. In Virginia the revenue to the State was $61,305. There was considerable interchange of persons, boats, and apparatus between private and public areas in both of these States, but in the above table they are shown where they did the most work.

Comparative Statistics of the Oyster Product of Maryland and Virginia for Various Years from 1880 to 1912.[a]

Years.	Maryland.		Virginia.	
	Bushels.	*Value.*	*Bushels.*	*Value.*
1880	10,600,000	$4,730,476	6,837,320	$2,218,376
1887	8,148,217	2,683,435	2,921,139	1,002,901
1888	8,531,658	2,877,790	3,664,433	1,336,012
1890	10,450,087	4,854,746	6,074,025	2,482,348
1891	9,945,058	5,295,866	6,162,086	2,524,348
1897	7,254,934	2,885,202	7,023,848	2,041,683
1901	5,685,561	3,031,518	7,885,447	2,923,456
1904	4,429,650	2,417,674	7,612,289	3,459,676
1908	6,232,000	2,228,330	5,075,000	2,347,780
1912	5,510,421	2,127,759	6,206,098	2,286,340

[a] The statistics for 1908 in this table are from data published by the Bureau of the Census. The products of Virginia for 1887 do not include those of the James and Potomac Rivers.

In the Pacific Coast States in 1912 there were 800 persons engaged in the oyster industry, and the amount of wages paid was $260,895. The output was 213,579 bushels of market and seed oysters, having a value of $676,243, of which 157,243 bushels, valued at $659,430, were from private grounds.

In California the oyster industry, including the cultivation of oysters and the oyster trade, centers in San Francisco, and the oyster grounds are located chiefly in San Francisco Bay, although there are oyster grounds also in Tomales and Humboldt Bays. In San Francisco Bay sting rays are abundant at times, and in order to protect the oysters from them stockades are built around the oyster grounds. These are usually made of pickets, 2 by 3 inches in size, and from 14 to 16 feet high. The oyster product of the State is all obtained from private grounds, and the season extends practically through the entire year. The yield of oysters was 68,037 bushels, valued at $280,344, of which all except 600 bushels of native oysters, valued at $1,800, were eastern oysters grown from seed oysters brought from the Atlantic coast and planted on the local beds. In addition to the eastern and native oysters produced on the west coast, market oysters from the Atlantic coast are also handled by the dealers at San Francisco.

In Oregon the oyster grounds are in Yaquina Bay. The product of native and eastern oysters in 1912 was 2,213 bushels, valued at $9,050. In Washington the oyster grounds are in Willapa Bay, Grays Harbor, and in the bays and inlets in Puget Sound. As in other States on the Pacific coast these oyster grounds are usually exposed at low tide, and in winter the oysters are in danger of freezing when the tide is out. In order to retain water on the grounds dikes have been built in some localities. Shells have been planted on grounds inclosed by dikes for the purpose of rendering the bottom suitable for oyster planting, and also to secure a set of oyster spat. Both native and eastern oysters are used for planting purposes. Some Japanese oysters were planted in Willapa Bay about 10 years ago. In 1912 about 20,000 of these oysters were planted as an experiment within the dikes on private beds in Hood Canal. The oyster product of Washington amounted to 143,329 bushels of native and eastern oysters, having a value of $386,849, about 61 per cent of which were from planted grounds.

Following are detailed statistics of the oyster industry of the Pacific Coast States in 1912:

Items.	California.		Oregon.						Washington.						Grand total.	
	Private areas.		Private areas.		Public areas.		Total.		Private areas.		Public areas.		Total.			
	Number.	*Value.*	*Number.*	*Value.*	*Number.*	*Value.*	*Number.*	*Value.*	*Number.*	*Value.*	*Number.*	*Value.*	*Number.*	*Value.*	*Number.*	*Value.*
Persons engaged:																
On vessels fishing									12				12		12	
On vessels transporting	3								5				5		8	
In shore or boat fisheries	119		18				18		390		99		489		626	
Shoresmen	90								64				64		154	
Total	212		18				18		471		99		570		800	
Wages paid:																
Dredging										$5,033				$5,033		$5,033
Tonging		$12,008		$1,600		$2,000		$3,600		40,435		$13,525		53,960		69,568
Transporting		4,240								10,375				10,375		14,615
Planting and transplanting		42,535								34,035				34,035		76,570
Protecting oysters from natural enemies										1,180				1,180		1,180
Wholesale trade		69,571								24,358				24,358		93,929
Total		128,354		1,600		2,000		3,600		115,416		13,525		128,941		260,895
Vessels, boats, apparatus, and other property:																
Vessels fishing									7	27,000			7	27,000	7	27,000
Net tonnage									59				59		59	
Vessels transporting	5	32,500							12	22,000			12	22,000	17	54,500
Net tonnage	82								78				78		160	
Gasoline boats	11	9,550	4	1,600			4	1,600	35	18,350			35	18,350	50	29,500
Sail and row boats	134	21,750	43	2,455			43	2,455	545	24,459			545	24,459	722	48,664
Apparatus—vessel fisheries—dredges									16	323			16	323	16	323
Apparatus—boat fisheries—																
Dredges									2	30			2	30	2	30
Tongs	178	1,254	50	800			50	800	694	3,457			694	3,457	922	5,511
Shore and accessory property		275,350								55,775				55,775		331,125
Cash capital		1,085,000								46,000				46,000		1,131,000
Total		1,425,404		4,855				4,855		197,394				197,394		1,627,653
Planting operations:																
Oyster grounds owned or leased.....acres	[a]35,448.12	449,775	41.83	16,000			41.83	16,000	15,934.05	832,830			15,934.05	832,830	51,424.00	1,298,605
Oyster grounds under culture.....acres	6,717.00		41.83				41.83		4,450.15				4,450.15		11,208.98	

Grounds planted during the year...acres..	100.00								529.00				529.00		629.00	
Materials planted during the year—																
Seed oysters, bushels	8,600	24,239							108,005	141,391			108,005	141,391	[b] 116,605	165,630
Oyster shells, bushels	6,000	600							33,650	4,550			33,650	4,550	39,650	5,150
Total		24,839								145,941				145,941		170,780
Expenses connected with planting—																
Planting and transplanting		2,026								12,275				12,275		14,301
Protecting oysters from natural enemies		8,915														8,915
Total		10,941								12,275				12,275		23,216
Oysters on private areas at the end of the year—																
Native....bushels..	3,100	6,390	500	900			500	900	555,425	832,570			555,425	832,570	559,025	839,860
Eastern.....do....	98,500	311,000	500	1,500			500	1,500	191,310	532,775			191,310	532,775	290,310	845,275
Total	101,600	317,390	1,000	2,400			1,000	2,400	746,735	1,365,345			746,735	1,365,345	849,335	1,685,135
Products:																
Vessel fisheries—with dredges—																
Market oysters, native....bushels..									4,300	12,200			4,300	12,200	4,300	12,200
Market oysters, eastern..bushels..									22,230	84,017			22,230	84,017	22,230	84,017
Total									26,530	96,217			26,530	96,217	26,530	96,217
Boat fisheries—																
With dredges—																
Market oysters, native, bushels									20	72			20	72	20	72
Market oysters, eastern, bushels									1,305	4,906			1,305	4,906	1,305	4,906

[a] Estimated.

[b] Includes 54,315 bushels of eastern oysters, valued at $139,453.

Oyster Industry of the Pacific Coast States, 1912—Continued.

Items.	California.		Oregon.						Washington.						Grand total.	
	Private areas.		Private areas.		Public areas.		Total.		Private areas.		Public areas.		Total.			
Products—Continued.																
Boat fisheries—Contd.																
With tongs—																
Market oysters, native, bushels	*Number.* 600	*Value.* $1,800	*Number.* 413	*Value.* $1,450	*Number.* 600	*Value.* $2,000	*Number.* 1,013	*Value.* $3,450	*Number.* 42,530	*Value.* $206,613	*Number.*	*Value.*	*Number.* 42,530	*Value.* $206,613	*Number.* 44,143	*Value.* $211,863
Market oysters, eastern, bushels	67,437	278,544	1,200	5,600	.....	.....	1,200	5,600	15,408	61,228	.....	.....	15,408	61,228	84,045	345,372
Seed oysters, native, bushels	.....	.....	.....	.....	.....	.....	.....	.....	1,800	3,000	55,736	$14,813	57,536	17,813	57,536	17,813
Total	68,037	280,344	1,613	7,050	600	2,000	2,213	9,050	61,063	275,819	55,736	14,813	116,799	290,632	187,049	580,026
Grand total	68,037	280,344	1,613	7,050	600	2,000	2,213	9,050	87,593	372,036	55,736	14,813	143,329	386,849	213,579	676,243
Wholesale trade:																
Market oysters sold in the shell, native, bushels	10,867	43,078	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	8,658	49,003	19,525	92,081
Market oysters sold in the shell, eastern, bushels	48,914	186,440	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	4,577	19,898	53,491	206,338
Oysters sold opened, native.....gallons	4,950	17,325	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	40,137	114,278	45,087	131,603
Oysters sold opened, eastern.....gallons	57,886	204,894	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	2,537	5,501	60,423	210,395
Oyster shells sold, bushels	63,700	2,345	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	5,600	830	69,300	3,175
Total	.....	454,082	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	189,510	.....	643,592
Expenses connected with wholesale trade	.....	25,267	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	16,338	.....	41,605

Note.—In addition to the oyster grounds shown for Washington in the above table as owned or leased, there are 22,477.89 acres which have been taken up, but have not been used for oyster planting. In Washington the revenue to the State from sales and leases of oyster grounds, tonging licenses, and commodity tax, in 1912, was $3,085. California and Oregon derive no revenue from oyster grounds. There was considerable interchange of persons, boats, and apparatus between private and public areas in Washington and Oregon, but in the above table they are shown where they did the most work.

COMPARATIVE STATISTICS OF THE OYSTER PRODUCT OF THE PACIFIC COAST STATES FOR VARIOUS YEARS FROM 1880 TO 1912.[a]

Years.	California.		Oregon.		Washington.		Total.	
	Bushels.	*Value.*	*Bushels.*	*Value.*	*Bushels.*	*Value.*	*Bushels.*	*Value.*
1880	(b)	(b)	(b)	(b)	15,000	$10,000	(b)	(b)
1888	130,000	$509,175	4,125	$6,250	60,993	86,574	195,118	$601,999
1889	146,150	571,525	1,666	3,125	125,790	128,604	273,606	703,254
1890	151,325	592,137	1,470	2,758	148,150	147,930	300,945	742,825
1891	158,130	618,455	1,622	3,043	166,428	154,961	326,180	776,459
1892	178,645	698,257	1,633	3,062	164,924	147,995	345,202	849,314
1895	163,636	539,497	1,480	2,220	108,067	109,232	273,183	650,949
1899	420,000	867,000	985	1,625	98,355	174,567	519,340	1,043,192
1904	188,613	628,023	992	1,488	191,208	402,012	380,813	1,031,523
1908	104,000	337,000	1,300	4,200	204,000	352,500	209,300	693,700
1912	68,037	280,344	2,213	9,050	143,329	386,849	213,579	676,243

[a] The statistics for 1908 in this table are from data published by the Bureau of the Census.
[b] Statistics not available.

VESSEL FISHERIES AT BOSTON AND GLOUCESTER.

Statistics of the vessel fisheries at Boston and Gloucester, Mass., have been collected and published as monthly and annual bulletins, giving the quantity and value of fishery products landed by American fishing vessels at each of these ports during the calendar year.

In 1912 there were landed at Boston 3,676 trips, amounting to 100,300,080 pounds of fish, valued at $2,731,391, and at Gloucester 3,973 trips, aggregating 82,403,979 pounds, valued at $2,047,868, a total of 7,649 trips and 182,704,059 pounds of fresh and salted fish, valued at $4,779,259. The receipts at Boston were all fresh fish except 143,000 pounds of salted mackerel, valued at $9,442, while at Gloucester they included 51,263,695 pounds of fresh fish, valued at $1,055,295 and 31,140,284 pounds of salted fish, valued at $992,573. Compared with 1911 there was an increase of 849 trips at the two ports, but a decrease of 2,449,308 pounds in the quantity and of $245,238 in the value of the products. The catch of cod and cusk did not vary materially from that of the previous year, but there was considerable decrease in the value. There was an increase in the catch of haddock and halibut, but a decrease in that of hake, pollock, mackerel, and other species. The dealers at Gloucester imported during the year 3,637,169 pounds of salted cod from Newfoundland and Nova Scotia.

Statistics of these fisheries are given in detail by months and fishing grounds in the following tables.

QUANTITY AND VALUE OF CERTAIN FISHERY PRODUCTS LANDED AT BOSTON AND GLOUCESTER, MASS., BY AMERICAN FISHING VESSELS DURING THE YEAR 1912, SHOWN BY MONTHS.

Month.	Number of trips.	Cod.				Cusk.				Haddock.			
		Fresh.		Salted.		Fresh.		Salted.		Fresh.		Salted.	
LANDED AT BOSTON.		*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
January	192	765,550	$36,590			146,400	$4,594			1,997,300	$66,355		
February	258	1,363,700	52,647			187,600	4,596			5,367,200	135,071		
March	322	3,074,900	95,074			235,900	5,396			6,134,700	134,889		
April	306	2,446,400	71,600			402,900	8,084			5,239,600	79,834		
May	230	2,301,100	55,757			469,600	8,274			2,552,900	64,450		
June	256	1,772,500	61,861			198,700	3,351			4,128,200	62,089		
July	335	1,682,700	67,869			98,400	2,042			3,705,750	70,212		
August	371	3,528,300	85,085			189,000	3,236			5,204,550	60,299		
September	398	1,797,250	66,613			202,300	3,852			5,754,200	95,205		
October	388	2,521,650	95,160			394,900	6,777			6,040,500	132,264		
November	374	1,093,500	50,700			360,000	6,615			3,452,400	119,151		
December	246	1,065,750	45,426			180,400	4,359			3,199,900	143,175		
Total	3,676	23,413,300	784,382			3,066,100	61,176			52,777,200	1,162,994		
LANDED AT GLOUCESTER.													
January	350	192,218	7,807	88,432	$4,873	17,830	359	1,255	$32	739,217	21,789	3,400	$55
February	278	164,890	7,040	729,010	33,490	6,131	134	2,141	53	428,674	10,783	6,295	93
March	436	2,184,545	50,319	255,566	12,317	34,981	570	5,185	130	1,960,361	45,459	5,124	77
April	428	1,734,089	34,924	635,597	23,195	282,988	4,153	4,005	100	3,991,868	51,751	10,665	161
May	265	1,705,416	31,167	1,571,494	54,256	613,064	8,373	2,235	57	354,842	6,828	24,200	339
June	189	2,078,995	34,640	4,144,695	130,172	344,197	4,475	11,755	294	278,617	1,988	47,495	623
July	229	979,990	16,486	2,250,260	72,913	502,038	6,517	54,388	1,227	638,490	4,482	60,643	807
August	202	1,303,920	22,037	2,302,621	73,217	619,988	8,049	33,219	746	687,870	4,815	46,265	581
September	189	838,150	14,803	1,883,938	61,519	467,229	5,942	22,145	497	632,790	4,938	50,370	688
October	147	615,767	12,176	1,821,846	72,971	238,270	3,114	10,755	248	462,305	5,528	34,589	533
November	592	127,385	3,109	2,314,617	98,606	77,057	1,000	9,880	223	96,970	2,978	21,695	327
December	668	179,855	8,561	188,232	9,053	47,295	615	6,406	158	175,585	8,535	11,610	174
Total	3,973	12,105,520	243,069	18,186,308	646,582	3,251,068	43,301	163,369	3,765	10,447,589	169,874	322,441	4,458
Grand total	7,649	35,518,820	1,027,451	18,186,308	646,582	6,317,168	104,477	163,369	3,765	63,224,789	1,332,868	322,441	4,458
Grounds E. of 66° west long.	741	10,838,253	269,819	14,988,605	521,029	2,602,783	41,444	75,041	1,728	6,110,770	140,993	156,409	2,177
Grounds W. of 66° west long.	6,908	24,680,567	757,632	3,197,703	125,553	3,714,385	63,033	88,328	2,037	57,114,019	1,191,875	166,032	2,281
Landed at Boston in 1911	3,971	21,704,300	714,514			2,916,800	61,058			47,687,300	1,126,744		
Landed at Gloucester in 1911	2,829	12,272,843	279,974	19,729,034	886,496	3,516,702	60,596	248,018	6,221	8,024,102	131,128	463,774	8,550

Month.	Hake.				Pollock.				Halibut.			
	Fresh.		Salted.		Fresh.		Salted.		Fresh.		Salted.	
LANDED AT BOSTON.	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
January	296,800	$11,925			114,900	$4,146			14,900	$2,122		
February	302,250	12,465			169,150	6,223			56,700	6,360		
March	595,700	20,101			146,300	5,399			46,200	6,222		
April	475,500	9,733			164,700	4,306			91,350	11,255		
May	838,300	10,685			294,250	4,843			80,400	7,304		
June	951,100	14,394			274,800	6,970			80,630	7,380		
July	699,500	12,872			254,200	8,862			166,000	13,679		
August	552,900	8,838			501,800	9,689			90,545	8,080		
September	1,124,100	20,697			622,500	16,054			70,590	7,962		
October	3,118,200	40,128			954,550	19,039			107,650	12,832		
November	1,982,200	34,954			599,200	8,357			27,475	5,048		
December	445,000	16,750			169,680	3,095			13,950	2,602		
Total	11,381,550	213,542			4,266,030	96,983			846,390	90,846		
LANDED AT GLOUCESTER.												
January	58,015	1,636	5,230	$98	405,173	15,607	12,056	$182	46,992	6,431	382	$33
February	7,952	255	1,370	20	203,611	8,442	15,292	230	141,685	13,795	5,655	463
March	27,233	428	995	14	169,913	5,744	8,270	124	220,123	20,317	45	4
April	234,539	2,191	2,203	33	213,821	4,248	14,725	222	153,225	17,231	860	68
May	691,472	5,354	8,716	118	976,806	8,014	19,885	275	178,133	14,264	232	19
June	474,713	3,359	83,508	1,044	141,245	1,095	82,125	1,179	432,443	29,214	47,156	3,753
July	351,359	2,443	47,127	592	189,555	1,361	37,247	555	229,446	15,671	2,173	174
August	477,010	3,338	33,458	417	41,935	336	32,385	487	266,882	25,104	11,408	913
September	630,310	5,306	35,006	524	69,178	553	23,191	349	263,182	28,965	393,327	39,288
October	356,865	4,090	32,465	517	122,400	1,348	22,247	368	158,635	18,692	18,496	1,852
November	480,715	5,529	13,065	210	4,290,451	44,165	24,485	368	77,653	12,576	965	97
December	117,000	3,894	6,555	101	3,269,231	50,659	15,405	232	45,847	7,459	204	21
Total	3,907,183	37,823	269,698	3,688	10,093,319	141,572	307,313	4,571	2,214,246	209,719	480,903	46,685
Grand total	15,288,733	251,365	269,698	3,688	14,359,349	238,555	307,313	4,571	3,060,636	300,565	480,903	46,685
Grounds E. of 66° west longitude	3,345,860	51,869	241,540	3,301	459,335	9,864	145,667	2,175	2,262,611	214,490	479,439	46,560
Grounds W. of 66° west longitude	11,942,873	199,496	28,158	387	13,900,014	228,691	161,646	2,396	798,025	86,075	1,464	125
Landed at Boston in 1911	11,337,925	227,327			5,095,840	121,381			748,850	65,811		
Landed at Gloucester in 1911	6,759,243	77,118	355,418	6,167	9,651,178	119,580	878,946	15,889	2,341,928	198,767	410,967	35,171

QUANTITY AND VALUE OF CERTAIN FISHERY PRODUCTS LANDED AT BOSTON AND GLOUCESTER, MASS., BY AMERICAN FISHING VESSELS DURING THE YEAR 1912, SHOWN BY MONTHS—Continued.

Month.	Mackerel.				Other fish.[a]				Total.				Grand total.	
	Fresh.		Salted.		Fresh.		Salted.		Fresh.		Salted.			
LANDED AT BOSTON.	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
January									3,335,850	$125,732			3,335,850	$125,732
February									7,446,600	217,362			7,446,600	217,362
March									10,233,700	267,081			10,233,700	267,081
April					6,100	$90			8,826,550	184,902			8,826,550	184,902
May									6,536,550	151,313			6,536,550	151,313
June	295,750	$29,564	40,600	$805	82,000	510			7,783,680	186,119	40,600	$805	7,824,280	186,924
July	241,595	21,892	2,000	110	1,014,350	93,370			7,862,495	290,798	2,000	110	7,864,495	290,908
August	378,275	20,272	4,600	1,896	637,100	49,840			11,082,470	245,339	4,600	1,896	11,087,070	247,235
September	1,547,175	72,994	95,800	6,631	159,300	19,036			11,277,415	302,413	95,800	6,631	11,373,215	309,044
October	8,400	665			3,040	549			13,148,890	307,414			13,148,890	307,414
November	25,425	3,109			8,000	135			7,548,200	228,069			7,548,200	228,069
December									5,074,680	215,407			5,074,680	215,407
Total	2,496,620	148,496	143,000	9,442	1,909,890	163,530			100,157,080	2,721,949	143,000	9,442	100,300,080	2,731,391
LANDED AT GLOUCESTER.														
January					4,387,500	131,625	4,119,128	$76,821	5,846,945	185,254	4,229,883	82,094	10,076,828	267,348
February					612,500	18,375	222,200	4,925	1,565,443	58,824	981,963	39,274	2,547,406	98,098
March									4,597,156	122,837	275,185	12,666	4,872,341	135,503
April					54,000	1,080			6,664,530	115,578	668,055	23,779	7,332,585	139,357
May							54,200	1,121	4,519,733	74,000	1,681,052	56,185	6,200,785	130,185
June	12,060	944	368,000	20,240	749,000	9,408	107,600	2,556	4,511,270	85,123	4,892,334	159,861	9,403,604	244,984
July	82,080	4,503	10,000	450	791,720	8,214			3,764,678	59,677	2,461,838	76,718	6,226,516	136,395
August	23,580	778	42,600	2,386	1,050,630	10,678	7,000	210	4,471,815	75,135	2,508,956	78,957	6,980,771	154,092
September	7,290	622	693,600	52,573	854,800	4,727			3,763,229	65,856	3,101,577	155,438	6,864,806	221,294
October	21,510	1,299	262,600	22,386	40,000	450			2,015,752	46,697	2,202,998	98,875	4,218,750	145,572
November	17,100	1,244	28,200	2,975	16,000	240	320,308	5,819	5,183,331	70,841	2,733,215	108,625	7,916,546	179,466
December					525,000	15,750	5,174,816	90,362	4,359,813	95,473	5,403,228	100,101	9,763,041	195,574
Total	163,620	9,390	1,405,000	101,010	9,081,150	200,547	10,005,252	181,814	51,263,695	1,055,295	31,140,284	992,573	82,403,979	2,047,868
Grand total	2,660,240	157,886	1,548,000	110,452	10,991,040	364,077	10,005,252	181,814	151,420,775	3,777,244	31,283,284	1,002,015	182,704,059	4,779,259
Grounds E. of 66° west longitude	123,000	18,191	450,200	25,432	5,647,540	180,353	9,998,252	181,604	31,390,152	927,023	26,535,153	784,006	57,925,305	1,711,029
Grounds W. of 66° west longitude	2,537,240	139,695	1,097,800	85,020	5,343,500	183,724	7,000	210	120,030,623	2,850,221	4,748,131	218,009	124,778,754	3,068,230
Landed at Boston in 1911	2,588,694	142,114	131,200	9,755	1,549,200	106,578			93,628,909	2,565,527	131,200	9,755	93,760,109	2,575,282
Landed at Gloucester in 1911	510,140	30,132	1,307,900	101,886	8,159,545	186,567	16,763,520	304,979	51,235,681	1,083,862	40,157,577	1,365,353	91,393,258	2,449,215

[a] Includes herring from Newfoundland—5,525,000 pounds frozen, $165,750, and 9,998,252 pounds salted, $181,604.

Fishing grounds.	Number of trips.	Cod.				Cusk.				Haddock.			
		Fresh.		Salted.		Fresh.		Salted.		Fresh.		Salted.	
		Pounds.	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
LANDED AT BOSTON.													
East of 66° west longitude.													
La Have Bank	16	261,000	$7,125			48,500	$895			682,600	$10,462		
Western Bank	22	699,100	21,535			38,000	936			126,000	1,950		
Quereau Bank	15	280,800	9,184			13,400	261			7,000	134		
Cape Shore	217	3,276,500	118,812			802,100	16,919			3,829,700	108,883		
West of 66° west longitude.													
Browns Bank	84	755,000	23,868			370,500	7,021			1,850,000	53,084		
Georges Bank	564	7,420,200	210,749			303,000	6,260			15,286,700	336,683		
Cashes Bank	8	28,400	807			81,200	1,226			7,000	194		
Clark Bank	5	67,700	2,093			2,800	43			131,000	1,515		
Fippennies Bank	1	2,000	100			4,000	120			2,000	100		
Middle Bank	371	526,300	21,905			188,700	3,968			1,843,500	64,339		
Jeffreys Ledge	374	574,250	24,700			326,700	6,387			1,195,050	43,733		
South Channel	868	5,837,150	211,694			310,400	6,033			22,925,400	459,033		
Nantucket Shoals	35	422,000	13,554			2,900	58			107,800	1,719		
Off Highland Light	11	11,000	494			4,600	118			155,400	5,249		
Off Chatham	244	929,550	32,030			39,800	758			3,441,000	84,656		
Shore, general	841	2,322,350	85,734			520,500	10,173			1,188,650	41,290		
Total	3,676	23,413,300	784,382			3,066,100	61,176			52,777,200	1,162,994		
LANDED AT GLOUCESTER.													
East of 66° west longitude.													
La Have Bank	54	913,726	18,076	75,822	82,765	555,800	7,142	4,049	$95	613,055	6,020	$15	$11
Western Bank	57	1,361,230	23,947	1,391,980	44,996	402,458	5,221	22,770	515	87,640	675	43,225	625
Quereau Bank	109	2,314,063	38,092	4,180,422	132,691	138,725	1,818	20,167	477	80,160	564	37,850	508
Green Bank	3			17,480	745			375	8				
Grand Bank	17	350,365	6,043	1,560,171	55,014	250	3					4,335	60
St. Peters Bank	5	8,885	155	723,835	22,187							2,220	28
Bacalieu Bank	1			20,965	749			55	1				
Off Newfoundland	74			2,812,146	103,767							29,857	392
Cape North	10	555,545	9,398	887,851	27,296	1,990	26	760	19	2,165	16	3,075	42
Cape Shore	97	618,031	13,798	238,003	9,557	555,830	7,329	26,025	596	677,005	12,245	1,790	76
Gulf of St. Lawrence	23	76,845	1,263	1,863,420	71,779	2,730	35	840	19			19,690	279
Greenland	1												
St. Anns Bank	8	83,428	1,647	692,260	27,895	2,200	29			2,640	29	13,552	206
The Gully	5	38,735	744	25,940	1,120	40,800	530			2,805	27		
Labrador Coast	7			498,640	20,468								

QUANTITY AND VALUE OF CERTAIN FISHERY PRODUCTS LANDED AT BOSTON AND GLOUCESTER, MASS., BY AMERICAN FISHING VESSELS DURING THE YEAR 1912, SHOWN BY MONTHS—Continued.

Fishing grounds.	Number of trips.	Cod.				Cusk.				Haddock.			
		Fresh.		Salted.		Fresh.		Salted.		Fresh.		Salted.	
LANDED AT GLOUCESTER—continued.													
West of 66° west longitude.		*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
Browns Bank	111	1,899,492	$35,896	521,243	$19,518	1,079,630	$14,442	19,971	$453	1,896,236	$14,634	41,005	$586
Georges Bank	268	2,778,632	56,855	2,663,170	105,454	312,981	4,166	68,357	1,584	3,253,537	37,098	124,902	1,693
Cashes Bank	5	21,095	392			53,715	733			350	2		
Middle Bank	25												
South Channel	27	420,957	8,538			21,475	278			670,560	8,156		
Nantucket Shoals	59	8,245	137							100	1		
Shore, general	3,007	656,246	28,038	13,290	581	82,484	1,249			3,161,336	90,409	125	2
Total	3,973	12,105,520	243,069	18,186,308	646,582	3,251,068	43,301	163,369	3,765	10,447,589	169,874	322,441	4,458
Grand total	7,649	35,518,820	1,027,451	18,186,308	646,582	6,317,168	104,477	163,369	3,765	63,224,789	1,332,868	322,441	4,458

Fishing grounds.	Hake.				Pollock.				Halibut.			
	Fresh.		Salted.		Fresh.		Salted.		Fresh.		Salted.	
LANDED AT BOSTON.												
East of 66° west longitude.	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
La Have Bank	76,000	$1,495			4,700	$120			44,700	$4,371		
Western Bank	38,000	595			69,000	2,498			171,700	17,127		
Quereau Bank	6,000	90							110,400	8,583		
Cape Shore	1,274,300	32,832			210,130	5,761			154,400	18,258		
West of 66° west longitude.												
Browns Bank	222,400	5,666			99,400	2,498			74,150	9,849		
Georges Bank	545,100	8,921			282,200	6,490			165,500	17,125		
Cashes Bank	255,000	4,055			6,500	138			2,000	180		
Clark Bank	21,300	316			3,800	101			1,700	149		

Fippenies Bank	6,000	300										
Middle Bank	1,034,500	26,165			189,800	5,008			6,200	933		
Jeffreys Ledge	1,153,400	25,791			888,400	20,991			14,185	1,213		
South Channel	4,325,700	66,295			608,000	14,227			84,475	11,164		
Nantucket Shoals	8,100	154			77,400	2,254			1,600	123		
Off Highland Light	14,100	638			6,300	231			200	24		
Off Chatham	304,400	7,741			162,900	4,246			5,600	673		
Shore, general	2,097,250	32,488			1,657,500	32,420			9,580	1,074		
Total	11,381,550	213,542			4,266,030	96,983			846,390	90,846		
LANDED AT GLOUCESTER.												
East of 66° west longitude.												
La Have Bank	554,648	4,395	16,092	$208	62,455	504	3,500	$54	132,700	12,418		
Western Bank	421,325	3,553	45,105	598	49,225	397	31,685	457	365,318	30,054	8,987	$724
Quereau Bank	340,762	2,683	86,699	1,182	22,150	215	56,922	850	627,432	55,516	24,121	1,977
Green Bank	19,560	230	1,785	27			540	9	58,583	8,615		
Grand Bank	21,270	149	7,410	94			5,830	98	90,210	7,526	4,362	373
St. Peters Bank			15,970	199			7,450	111			2,148	172
Bacalieu Bank	3,000	36	3,740	65					15,500	1,163	2,185	219
Off Newfoundland			7,368	100			6,095	92			2,470	208
Cape North	20,950	147	17,660	221	995	8	10,260	141	28,270	2,323	2,982	239
Cape Shore	512,620	5,098	20,068	309	39,335	350	7,485	115	220,227	27,893	145	11
Gulf of St. Lawrence	11,130	78	9,248	121	240	2	10,560	160	146,911	9,644	27,762	2,207
Greenland											13,885	1,389
St. Anns Bank			5,995	94	290	2	5,140	85			1,340	135
The Gully	46,295	488	4,400	83	815	7	200	3	96,260	10,999		
Labrador Coast											389,052	38,906
West of 66° west longitude.												
Browns Bank	1,007,166	7,559	17,213	232	86,671	692	33,553	504	41,678	3,836	950	78
Georges Bank	152,837	1,330	10,770	152	53,498	460	126,962	1,875	390,641	39,644	514	47
Cashes Bank	50,295	387			3,780	31						
Middle Bank												
South Channel	150,135	1,715			14,185	115						
Nantucket Shoals					542,740	4,107						
Shore, general	595,190	9,975	175	3	9,216,940	134,682	1,131	17	516	88		
Total	3,907,183	37,823	269,698	3,688	10,093,319	141,572	307,313	4,571	2,214,246	209,719	480,903	46,685
Grand total	15,288,733	251,365	269,698	3,688	14,359,349	238,555	307,313	4,571	3,060,636	300,565	480,903	46,685

QUANTITY AND VALUE OF CERTAIN FISHERY PRODUCTS LANDED AT BOSTON AND GLOUCESTER, MASS., BY AMERICAN FISHING VESSELS DURING THE YEAR 1912, SHOWN BY FISHING GROUNDS—Continued.

Fishing grounds.	Mackerel.				Other fish.				Total.				Grand total.	
	Fresh.		Salted.		Fresh.		Salted.		Fresh.		Salted.			
LANDED AT BOSTON.														
East of 66° west longitude.	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
La Have Bank									1,117,500	$24,458			1,117,500	$24,458
Western Bank					2,600	$208			1,144,400	44,849			1,144,400	44,849
Quereau Bank									417,600	18,252			417,600	18,252
Cape Shore	117,600	$17,795	40,600	$805	119,940	14,395			9,784,670	333,655	40,600	$805	9,825,270	334,460
West of 66° west longitude.														
Browns Bank					15,000	1,632			3,386,450	83,618			3,386,450	83,618
Georges Bank	20,400	2,040			1,440,050	125,024			25,463,150	683,292			25,463,150	683,292
Cashes Bank					14,400	1,728			394,500	8,328			394,500	8,328
Clark Bank									228,300	4,217			228,300	4,217
Fippenies Bank									14,000	620			14,000	620
Middle Bank	207,500	10,231	1,800	96					3,996,300	132,547	1,800	96	3,998,100	132,643
Jeffreys Ledge					15,100	1,561			4,167,085	124,376			4,167,085	124,376
South Channel					[a] 21,600	1,927			34,110,725	770,373			34,110,725	770,373
Nantucket Shoals	900	24			[b] 40,500	360			661,200	18,246			661,200	18,246
Off Highland Light									191,600	6,754			191,600	6,754
Off Chatham	717,175	44,966	32,800	3,972					5,601,025	175,050	32,800	3,972	5,633,825	179,022
Shore, general	1,433,045	73,440	67,800	4,569	[c] 240,700	16,695			9,478,575	293,314	67,800	4,569	9,546,375	297,883
Total	2,496,620	148,496	143,000	9,442	1,909,890	163,530			100,157,080	2,721,949	143,000	9,442	100,300,080	2,731,391
LANDED AT GLOUCESTER.														
East of 66° west longitude.														
La Have Bank									2,832,384	48,855	100,278	3,131	2,932,662	51,986
Western Bank									2,687,196	63,847	1,543,752	47,915	4,230,948	111,762
Quereau Bank									3,523,292	98,888	4,406,181	137,685	7,929,473	236,573
Green Bank									78,143	8,845	19,880	789	98,023	9,634
Grand Bank									462,095	13,721	1,582,108	55,639	2,044,203	69,360
St. Peters Bank									8,885	155	751,623	22,697	760,508	22,852
Bacalieu Bank									18,500	1,199	26,945	1,034	45,445	2,233
Off Newfoundland					[d] 5,525,000	165,750	[d] 9,998,252	$181,604	5,525,000	165,750	12,856,188	286,163	18,381,188	451,913
Cape North									609,915	11,918	922,588	27,958	1,532,503	39,876

Cape Shore	5,400	396	394,600	23,127					2,628,448	67,107	688,116	33,741	3,316,564	100,848
Gulf of St. Lawrence			15,000	1,500					237,856	11,022	1,946,520	76,065	2,184,376	87,087
Greenland											13,885	1,389	13,885	1,389
St. Anns Bank									88,558	1,707	718,287	28,415	806,845	30,122
The Gully									225,710	12,795	30,510	1,206	256,220	14,001
Labrador Coast											887,692	59,374	887,692	59,374
West of 66° west longitude.														
Browns Bank					920	92			6,011,793	77,151	633,935	21,371	6,645,728	98,522
Georges Bank					[e] 44,000	718			6,986,126	140,271	2,994,675	110,805	9,980,801	251,076
Cashes Bank									129,235	1,545			129,235	1,545
Middle Bank	80,820	3,522	23,000	1,088			[d] 7,000	210	80,820	3,522	30,000	1,298	110,820	4,820
South Channel									1,277,312	18,802			1,277,312	18,802
Nantucket Shoals	8,460	737	918,600	70,798					559,545	4,982	918,600	70,798	1,478,145	75,780
Shore, general	68,940	4,735	53,800	4,497	[f] 3,511,230	33,987			17,292,882	303,213	68,521	5,100	17,361,403	308,313
Total	163,620	9,390	1,405,000	101,010	9,081,150	200,547	10,005,252	181,814	51,263,695	1,055,295	31,140,284	992,573	82,403,979	2,047,868
Grand total	2,660,240	157,886	1,548,000	110,452	10,991,040	364,077	10,005,252	181,814	151,420,775	3,777,244	31,283,284	1,002,015	182,704,059	4,779,259

[a] Butterfish, 6,500 pounds, value $325; and swordfish, 15,100 pounds, value $1,602.
[b] Menhaden, 40,000 pounds, value $300; and swordfish, 500 pounds, value $60.
[c] Herring, 14,100 pounds, value $225; menhaden, 42,000 pounds, value $210; and swordfish, 184,600 pounds, value $16,260.
[d] Herring.
[e] Shad.
[f] Bluebacks, 2,355,200 pounds, value $21,213; butterfish, 1,200 pounds, value $48; herring, 345,600 pounds, value $5,243; menhaden, 439,200 pounds, value $2,278; shad, 368,400 pounds, value $5,068; and swordfish, 1,630 pounds, value $137. All other items under "Other fish" are swordfish.

Approximately two-thirds of the fishery products landed at Boston and Gloucester, Mass., by American fishing vessels during the year, or 68.29 per cent of the quantity and 64.20 per cent of the value, were from fishing grounds lying directly off the coast of the United States; 11.67 per cent of the quantity and 11.63 per cent of the value from grounds off the coast of Newfoundland; 19.53 per cent of the quantity and 22.89 per cent of the value from grounds off the Canadian Provinces; and less than 1 per cent of the quantity and 1.27 per cent of the value from the coasts of Greenland and Labrador. Newfoundland herring constituted 8.49 per cent of the quantity and 7.26 per cent of the value of the products of the vessel fisheries of these ports. The herring were taken on the treaty coast of Newfoundland, but cod and other species from that region were obtained chiefly from fishing banks on the high seas. The fish caught by American fishing vessels off the Canadian Provinces were all from offshore fishing grounds. The catch from each of these fishing regions is given in detail in the following table:

QUANTITY AND VALUE OF FISH LANDED BY AMERICAN FISHING VESSELS AT BOSTON AND GLOUCESTER, MASS., IN 1912, FROM GROUNDS OFF THE COASTS OF THE UNITED STATES, NEWFOUNDLAND, AND CANADIAN PROVINCES.

Species.	United States.		Newfoundland.[a]		Canadian Provinces.		Total.	
	Pounds.	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
Cod:								
Fresh	24,680,567	$757,632	359,250	$6,198	10,479,003	$263,621	35,518,820	$1,027,451
Salted	3,197,703	125,553	5,632,937	202,930	9,355,668	318,099	18,186,308	646,582
Cusk:								
Fresh	3,714,385	63,033	250	3	2,602,533	41,441	6,317,168	104,477
Salted	88,328	2,037	430	9	74,611	1,719	163,369	3,765
Haddock:								
Fresh	57,114,019	1,191,875	.....	.....	6,110,770	140,993	63,224,789	1,332,868
Salted	166,032	2,281	36,412	480	119,997	1,697	322,441	4,458
Hake:								
Fresh	11,942,873	199,496	43,830	415	3,302,030	51,454	15,288,733	251,365
Salted	28,158	387	36,273	485	205,267	2,816	269,698	3,688
Pollock:								
Fresh	13,900,014	228,691	.....	.....	459,335	9,864	14,359,349	238,555
Salted	161,646	2,396	19,915	310	125,752	1,865	307,313	4,571
Halibut:								
Fresh	798,025	86,075	164,293	17,304	2,098,318	197,186	3,060,636	300,565
Salted	1,464	125	414,102	41,267	65,337	5,293	480,903	46,685
Mackerel:								
Fresh	2,537,240	139,695	.....	.....	123,000	18,191	2,660,240	157,886
Salted	1,097,800	85,020	.....	.....	450,200	25,432	1,548,000	110,452
Herring:								
Fresh	359,700	5,468	5,525,000	165,750	.....	.....	5,884,700	171,218
Salted	7,000	210	9,998,252	181,604	.....	.....	10,005,252	181,814
Swordfish:								
Fresh	1,687,300	148,096	.....	.....	122,540	14,603	1,809,840	162,699
Other fish:								
Fresh	3,296,500	30,160	.....	.....	.....	.....	3,296,500	30,160
Total	124,778,754	3,068,230	22,230,944	616,755	35,694,361	1,094,274	182,704,059	4,779,259

[a] Includes 13,885 pounds of salted halibut, valued at $1,389, from Greenland; and 498,640 pounds of salted cod, valued at $20,468; and 389,052 pounds of salted halibut, valued at $38,906, from the Labrador coast.

The mackerel fishery continues to be unsuccessful. The catch of mackerel in New England in 1912 amounted to 31,861 barrels fresh and 8,267 barrels salted, as against 43,541 barrels fresh and 6,633 barrels salted in the previous year. The quantity landed at Boston

the fact that the Kodiak cannery had about made a capacity pack before the appearance of the cohos. Other localities, doubtless, would have shown a run equal to that of last year. Dog salmon were very scarce, only a few being taken during the season.

The total value to the fishermen of the salmon taken from Afognak waters was $4,155, or $243 less than the amount reported as the value of last year's catch. The fishermen were paid at the rate of $35 per thousand for sockeyes and cohos and at the rate of $10 per thousand for humpbacks. All salmon taken commercially from Afognak waters were sold to the Kodiak Fisheries Co. at Kodiak.

Eruption of Katmai Volcano.

In view of the important and more or less disastrous effect which the eruption of Katmai Volcano in June, 1912, had upon the fisheries, fur animals, and other animal and plant life of the Afognak Island Reservation, E. M. Ball, inspector, Alaska salmon fisheries, then at Afognak, was instructed to make a special investigation of the subject. He did so, and his report, which covers well many phases of the matter, is here presented.

The data which are presented in this report were obtained from two sources; direct examinations, and conversations with fishermen, boatmen, and miners. The results of personal investigations treat almost exclusively of conditions on Afognak Island; while the information received from individuals refers to localities beyond the reach of the writer. Where a number of opinions are concerned, each differing widely in essential features, it is not always easy to ascertain the facts. First reports are often unduly colored by the stress of the moment, and, therefore, in the light of subsequent events, are subject to modification. Enough is known, however, now three months after the eruption in question, to warrant the preparation of a brief report thereon, and its effect upon the animal and vegetable life of Afognak Island.

Description of volcano.—The Alaska Peninsula forms an important link in the chain of volcanoes which extend the entire length of the Pacific coast of the American Continents; and, as a region of volcanic activities, it is, perhaps, second only to the great centers of the Torrid Zone. These activities are made known by the smoking volcanoes of Redoubt and Iliamna on the shore of Cook Inlet, Pavlof on the western end of the peninsula, and Shishaldin on Unimak Island. Many others less notable occupy the intermediate territory, some of which are of comparatively recent discovery.

To this class belongs Katmai Volcano, a peak 7,500 feet high. It is located near latitude 58° 16′ and longitude 155°, or about 20 miles north of Katmai Bay and 60 miles west of Afognak. Information as to its general appearance is not obtainable, but prospectors and hunters who in other years had traveled through that section of the country tell us that the volcano is not marked by any great prominence and is not readily distinguishable from several peaks in its vicinity of approximately the same elevation. Neither they nor those who have always lived in this region have any knowledge either direct or traditional of its former activities. As far as the Kodiak group of islands is concerned, many believe that indications of a previous eruption can be found several inches below the surface of the ground in a layer of soil which in color and composition resembles the ashes now covering the islands; but the acceptance of such evidence as a scientific fact is questionable.

The eruption.—In the history of volcanoes elsewhere, it has been recorded that approaching eruptions were preceded by rumbling noises and trembling movements of the earth. In this instance, however, no warning was given to the people of Afognak

claimed by them that if continued any great length of time on a large scale the fishing grounds will eventually be destroyed. On the other hand, those using or advocating the use of otter trawls in the capture of ground fish assert that this apparatus is no more destructive to fish or injurious to the fishing grounds than other forms of fishing gear now employed in the various branches of the fishing industry.

In the calendar year 1912 the otter-trawl fleet landed at Boston over 16,000,000 pounds of fish, of which nearly 14,000,000 pounds were haddock. It is probable that in 1913 this amount will be exceeded by several million pounds.

This fleet of vessels has confined its fishing chiefly to Georges Bank and adjacent grounds. In March, however, owing to the scarcity of fish on Georges, a portion of the fleet fished on Western Bank, which was the first time since this method of fishing was introduced in New England that vessels operating otter trawls have operated on other fishing grounds than Georges. Several trips were made to Western Bank, after which the entire fleet repaired to Georges and the South Channel, shifting from one ground to the other according to the abundance or scarcity of fish found. At times the otter trawlers have landed a part of their catch of haddock at Portland, Me., for canning purposes.

This fishery has been under constant investigation by the Bureau for the purpose of determining, among other things, the extent of the destruction of immature fish, which is an unavoidable feature of this method, varying with the grounds and the season. Agents of the Bureau have been placed on the trawling vessels in order to obtain information as to the composition of each haul of the net, and a vast amount of data has thus been secured. It is expected that the inquiry will be practically completed by the end of the calendar year 1913, and a report will then be prepared as soon as practicable giving the results of the inquiry and containing recommendations, as required by Congress. The work of the Bureau has been facilitated by the owners of the trawling fleet, who have made no objection to the presence of the agents on board any or all of the vessels.

GILL-NET FISHING FOR COD AND HADDOCK.

The style of gill nets used on the Great Lakes was introduced into New England fisheries about three years ago. The first year a few vessels or power boats were brought by lake fishermen for the purpose of testing the fishing grounds in the vicinity of Cape Ann. The result of the experiment was very satisfactory, and the following year, 1911, about 20 vessels were employed, a number of which were Gloucester vessels, manned by fishermen from that port. In the winter of 1912 a number of captains, who had generally followed the haddock fishery in winter, engaged in net fishing, which increased the

netting fleet to 38 vessels. Few fish were taken by this method that year during the winter months, and not until early spring were any considerable quantities caught, and only a portion of the fleet realized enough profit on their catch to pay for the gear purchased. In the early inception of this method of fishing only grounds in the immediate vicinity of Cape Ann were resorted to, but during the past season scarcely any fish were caught close inshore, and the fleet was compelled to seek fishing banks lying from 8 to 12 miles offshore.

About 20 years ago cod gill-net fishing was extensively carried on in Ipswich Bay and on other local grounds, but in recent years, owing to the scarcity of fish on those grounds, only a small number of vessels have employed gill nets for the capture of cod. The difference between cod gill nets and the nets introduced by lake fishermen is chiefly in the manner in which they are set and hauled, size of mesh, and kind of floats and sinkers used. Cod gill nets are 35 fathoms long, from 6 to 8 feet deep, and the size of mesh is 9½ and 10 inches. Large glass globes attached at regular intervals along the head rope serve as floats. On the footrope opposite each globe is attached a brick. The buoyancy of the floats combined with the weight of the bricks keeps the nets perpendicular in the water. They are set and hauled from dories.

The nets introduced by the lake fishermen are 50 fathoms long, from 6 to 8 feet deep, and the size of mesh is 6 and 6½ inches. The twine generally used is linen, although cotton twine is now employed to some extent. The floats are of wood and aluminum. To keep the net in an upright position when set a lead sinker is attached to the foot line opposite each float. These nets, like cod nets, are set at and near the bottom, but instead of being set from dories they are payed out over the stern from boxes while the vessel is going at slow speed. A box contains 4 nets of 50 fathoms each, and 12 boxes of nets constitute a string. The number of boxes set at one time depends upon the condition of the weather. The nets are hauled by a lifter, sometimes called an "iron man," rigged on the port side just aft of the wheelhouse. A separate engine is used for operating the lifter. The fish, on coming to the surface, are taken from the nets and placed in boxes. Each vessel or boat has three strings of nets. The weather permitting, one string is in the water, one on the vessel ready to set as soon as a haul has been made, and another on the wharf undergoing repairs, no mending being done on the vessel. Haddock is the principal species taken, but cod and pollock are also obtained in considerable quantities.

PACIFIC COAST FISHERIES.

The salmon fisheries of the Pacific coast were in a prosperous condition in 1912, but the pack of canned salmon was slightly smaller than in the previous year, although there was a large increase in the pack in Alaska. The year was not a prosperous one for the purse-seine fishery for salmon on Puget Sound. Compared with the previous year, however, there was an increase from 136 to 170 in the number of purse-seine boats employed in this fishery. The halibut catch in 1912 varied but little from that of the previous year, being about 35,000,000 pounds. The product in 1912 was reported to have been marketed at higher prices on the average than in 1911. The cod fishery was carried on by 7 firms having 13 vessels, 8 of which sailed from San Francisco and 5 from Puget Sound ports, and the catch for the year amounted to about 9,300,000 pounds.

The work of collecting statistics of the quantity and value of fishery products landed at Seattle, Wash., by American fishing vessels and boats, and also by freight steamers, was begun about the middle of February, 1912. The only fish reported to have been landed that month, after this work began, was 629,625 pounds of fresh halibut from Flattery Bank, valued at $27,773. An interruption in the work occurred early in July on account of the resignation of the local agent at Seattle, and consequently the returns for July and August are incomplete. The work was resumed early in August and continued to the end of April the following year.

The principal species of fish landed at Seattle during the period covered by the returns were halibut, herring, and salmon. Black cod, cod, and various other species were also landed in considerable quantities. The products were obtained chiefly from Alaska, Flattery Bank, and Puget Sound. Statistics of the quantity and value of fishery products landed at this port, so far as available, are given by months from March to December, 1912, and from January to April, 1913, in the following tables.

QUANTITY AND VALUE OF CERTAIN FISHERY PRODUCTS LANDED AT SEATTLE, WASH., BY AMERICAN FISHING VESSELS AND BOATS, AND FREIGHT STEAMERS, FROM MARCH, 1912, TO APRIL, 1913.

Months.[a]	Number of trips.	Black cod.				Cod.				Halibut.				Herring.			
		Fresh.		Salted.		Fresh.		Salted.		Fresh.		Salted.		Fresh.		Salted.	
1912.		*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
March	78	.....	.....	.....	.....	.....	.....	.....	.....	2,931,919	$152,331	.....	.....	.....	.....	.....	.....
April	91	.....	.....	.....	.....	.....	.....	.....	.....	3,940,289	165,509	.....	.....	.....	.....	.....	.....
May	93	.....	.....	.....	.....	.....	.....	.....	.....	3,085,635	104,117	.....	.....	.....	.....	.....	.....
June	86	40,000	$1,455	.....	.....	.....	.....	.....	.....	3,290,000	152,312	.....	.....	.....	.....	.....	.....
July	16	.....	.....	.....	.....	.....	.....	.....	.....	1,086,000	38,220	.....	.....	.....	.....	.....	.....
August	86	39,065	1,095	.....	.....	28,195	$1,300	100	$5	3,062,995	143,774	.....	.....	2,400	$120	.....	.....
September	110	17,025	2,420	400	$25	3,825	135	764,000	18,325	2,956,930	139,070	.....	.....	.....	.....	125,100	$4,255
October	78	2,200	110	.....	.....	.....	.....	9,200	480	2,681,420	167,680	16,800	$855	.....	.....	224,125	7,615
November	104	2,255	165	7,700	280	.....	.....	.....	.....	2,310,945	145,045	.....	.....	23,520	596	2,085,380	35,875
December	76	1,500	70	6,510	275	.....	.....	15,060	375	1,073,935	65,060	35,620	1,070	.....	.....	5,231,450	134,129
Total	818	100,115	5,035	14,610	575	32,020	1,435	788,400	19,185	27,019,178	1,273,818	52,420	1,425	25,920	716	7,666,065	181,874
1913.																	
January	78	9,100	364	8,600	430	.....	.....	.....	.....	763,810	60,079	200	16	21,180	191	3,488,450	48,257
February	66	11,835	497	200	15	.....	.....	.....	.....	2,236,390	175,028	.....	.....	512,100	4,029	73,975	1,156
March	94	31,380	1,345	700	53	.....	.....	.....	.....	3,508,500	241,274	.....	.....	722,220	3,277	3,500	175
April	97	21,440	712	600	30	.....	.....	.....	.....	2,777,055	186,883	.....	.....	195,200	895	10,900	477
Total	335	73,755	2,828	10,100	528	.....	.....	.....	.....	9,345,815	661,264	200	16	1,450,700	8,392	3,576,825	50,065

[a] Statistics from March to July, inclusive, include fish landed at Tacoma.

QUANTITY AND VALUE OF CERTAIN FISHERY PRODUCTS LANDED AT SEATTLE, WASH., BY AMERICAN FISHING VESSELS AND BOATS, AND FREIGHT STEAMERS, FROM MARCH, 1912, TO APRIL, 1913—Continued.

Month.[a]	Salmon.										Other fish, fresh.		Total.			
	Coho, or silver.		Dog, or chum.		Humpback, or pink.		King, or spring.		Sockeye, or red.				Fresh.		Salted.	
1912.	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*
March	.....	.....	.....	.....	.....	.....	18,000	$2,025	.....	.....	.....	.....	2,949,919	$154,356	.....	.....
April	.....	.....	.....	.....	.....	.....	264,900	27,519	.....	.....	.....	.....	4,205,189	193,088	.....	.....
May	.....	.....	.....	.....	.....	.....	237,300	20,760	.....	.....	.....	.....	3,922,935	125,257	.....	.....
June	.....	.....	.....	.....	.....	.....	544,700	59,423	.....	.....	15,000	$600	3,895,700	213,470	.....	.....
July	8,000	$400	11,000	$550	.....	.....	428,400	35,176	.....	.....	13,500	540	1,540,900	75,186	.....	.....
August	176,820	10,370	1,001,144	58,098	6,017,038	$438,388	399,651	31,447	1,580,912	$192,612	129,310	5,492	12,457,520	880,096	100	$5
September	942,890	68,645	4,711,346	242,106	4,640,195	247,625	679,080	50,000	6,143,740	660,515	117,285	5,635	20,201,386	1,410,301	829,500	22,600
October	675,250	26,665	470,955	5,385	.....	.....	53,425	3,130	.....	.....	26,440	1,045	3,909,700	204,015	250,225	8,950
November	308,955	10,760	911,470	10,300	.....	.....	9,270	625	.....	.....	97,435	4,480	3,062,950	171,911	2,093,090	36,155
December	5,000	265	130,730	3,935	.....	.....	3,225	265	.....	.....	185,595	11,795	1,399,985	81,840	5,288,650	135,849
Total	2,116,915	117,105	7,236,645	320,434	10,657,233	686,013	2,637,951	230,430	7,724,652	853,127	584,565	28,697	58,135,194	3,516,180	8,461,565	203,559
1913.																
January	350	25	76,705	2,165	.....	.....	16,770	1,418	.....	.....	143,055	10,159	1,030,970	74,401	3,497,250	48,697
February	.....	.....	.....	.....	.....	.....	19,345	2,227	.....	.....	159,910	11,561	2,939,580	191,252	74,175	1,171
March	.....	.....	3,500	350	.....	.....	15,910	1,693	590	25	240,610	18,290	4,582,770	266,254	4,200	228
April	.....	.....	.....	.....	.....	.....	140,040	12,364	5,700	435	160,515	9,881	3,299,950	211,170	11,500	507
Total	350	25	80,205	2,515	.....	.....	192,065	17,702	6,290	460	704,090	49,891	11,853,270	743,077	3,587,125	50,603

[a] Statistics from March to July, inclusive, include fish landed at Tacoma.

SHAD AND HERRING FISHERIES OF CHESAPEAKE BAY.

Inquiries conducted by the Bureau show that the spring fishing season of 1913 was the poorest in many years in most parts of the Chesapeake Basin, and the aggregate catch of the principal spring fish—shad and herring—much less than in recent years. The effects of the diminished run of fish will be seen from three to five years hence, when the reduced progeny of the 1913 season's supply comes back to spawn.

The conditions in the Potomac River, which may be taken as typical for all the major streams, were in some respects the worst in 40 years. The upper reaches of the river were almost barren of fish during the entire season, and nearly all the shad and herring fishermen failed to meet expenses. At Ferry Landing, Va., the largest seine on the river, 1,200 fathoms long, discontinued operations in the middle of the season owing to the scarcity of fish. In former years this celebrated fishing shore, with a smaller seine, sometimes yielded 200,000 or more herring at a haul, and up to 10 or 15 years ago took probably 15,000 to 30,000 fish at a haul on an average. Only a few years back from 1,000 to 1,500 shad were frequently taken at one set of the seine. In 1913 the largest haul was 3,000 herring and 100 shad, while many times only 6 to 20 shad were taken.

The shad hatcheries operated by the Bureau on the Potomac and Susquehanna Rivers had a very unsuccessful season. Their operations afford a good criterion of the condition of the fishery in the fresh waters, because the whole field is covered and nearly every ripe fish that is caught by the fishermen is stripped of its eggs by spawn takers sent out from the hatcheries.

Shad culture on a scale that is entirely feasible can, with minor protective legislation, maintain the shad fishery in almost any stream, but shad culture under existing conditions is deprived of one very essential requirement, namely, an adequate supply of ripe eggs for hatching purposes.

The immediate cause of the failure of the shad and herring fisheries in 1913 is the diminished run of spawning fish into Chesapeake Bay from the sea and the enormous quantity of apparatus among which a limited catch had to be divided. Inasmuch as the great bulk of the yield is taken in salt water, the remnant that was able to reach the spawning grounds in the streams was insignificant and wholly inadequate to maintain the supply.

The remote cause of the present condition is excessive fishing in former years and the lack of even the minimum amount of protection that is demanded by regard for the most elementary principles of fishery conservation. Fish entering Chesapeake Bay have to run through such a maze of nets that the wonder is that any are able to

reach their spawning grounds and deposit their eggs. The mouth of every important shad and herring stream in the Chesapeake Basin is literally clogged with nets that are set for the special purpose of intercepting every fish, whereas a proper regard for the future welfare of the fisheries and for the needs of the migrating schools would cause the nets to be set so as to insure the escape of a certain proportion of the spawning fish.

Adequate protection of the fishes is compatible with great freedom of fishery and with a large and increasing yield. A very slight curtailment of the catch, perhaps as little as 10 per cent in any given year, may be sufficient to perpetuate the species and result in increased production in a few years. To disregard a requirement so small and to permit the continuance of an evil so serious simply invites and encourages the destruction of a most valuable food supply.

These conditions demand the immediate attention of the States and the application of a radical remedy. Their failure or inability to meet the situation by individual and cooperative action would seem to call for interference on the part of the Federal Government, a course which is being strongly urged by many thoughtful persons in the case of fishes which are migratory and can not be regarded as the property of any particular State.

PASSING OF THE STURGEON.

The story of the sturgeons is one of the most distressing in the whole history of the American fisheries. These large, inoffensive fishes of our seaboards, coast rivers, and interior waters were for years considered to be not only valueless but nuisances, and whenever they became entangled in the fishermen's nets they were knocked in the head or otherwise mortally wounded and thrown back into the water. Even in the present generation we have seen the shores of the Potomac River in the vicinity of Mount Vernon lined with the decomposing carcasses of these magnificent fishes, witnesses to the cruelty, stupidity, and profligacy of man, and the same thing has been observed everywhere in our country.

The next chapter in the story was the awakening of the fishermen to the fact that the eggs of the sturgeons had value as caviar and that the flesh had value as food. Then followed the most reckless, senseless fishing imaginable, with the result that in a comparatively few years the best and most productive waters were depleted, and what should have been made a permanent fishery of great profit was destroyed. Even after the great value of the sturgeon began to be appreciated by every one, the immature and unmarketable fish incidentally caught in seines, gill nets, and pound nets received no protection whatever in most waters and were ruthlessly destroyed as nuisances, the decline being thus doubly accelerated.

On the Atlantic coast the catch of the sturgeon fell from 7,000,000 pounds to less than 1,000,000 in 15 years; on the Pacific coast the same meteoric history was enacted, a catch of over 3,000,000 pounds annually in the early nineties being followed by a few hundred thousand pounds in later years of the same decade, with no improvement since that time, while on the Great Lakes the yield declined more than 90 per cent in 18 years. In the American waters of the Lake of the Woods, one of the most recent grounds for the exploitation of the sturgeon, the catch decreased over 96 per cent in 10 years, notwithstanding a more active prosecution of the fishing.

The sturgeon fishery as a whole reached its climax about 1890. For two or three years the annual catch was 12,000,000 to 15,000,000 pounds. At the present time the total yield does not exceed 1,000,000 pounds, and everywhere there is a steady downward trend in the catch. Some rivers that formerly supported a flourishing fishery are now absolutely depleted. The scarcity of the sturgeon and the demand for their flesh and eggs have run up the price to an extraordinary figure, never attained by any other fish, either in America or elsewhere. A mature female sturgeon often brings the fisherman more than $150 and it is a poor fish that can not be sold for $20 to $30 on the rivers of the east coast.

The most serious aspect of the sturgeon fishery is that, owing to the decimation of the schools of breeding fish and to peculiarities in spawning habits, it has been impossible as yet to inaugurate sturgeon culture anywhere in America. Attempts at artificial propagation have proved utter failures on the Great Lakes, Lake of the Woods, Lake Champlain, Delaware River and other waters, and the expenditure of considerable sums of money by the Bureau has sometimes failed to yield a single batch of eggs suitable for incubation.

Everywhere in America, under existing conditions, the sturgeons are doomed to commercial extinction, and it requires no prophet to foretell that in a comparatively few years the sturgeon will be practically extinct.

What is demanded in every State in which these fishes exist or have existed is absolute prohibition of capture or sale for a long term of years, certainly not less than 10. To advocate any less radical treatment would be only trifling with the situation.

A possible relief may be afforded by the Bureau through the transplanting in our waters of young sturgeon from other countries; and it may be noted that a supply of young fish of a very desirable species inhabiting the Danube River and the Caspian Sea has been kindly offered by the Roumanian Government. The successful administration of the sturgeon fisheries of southeastern Europe and the feasibility of undertaking the importation of young fish best adapted for American waters should receive attention.

FLORIDA SPONGE FISHERIES.

After seven years of earnest but futile effort the Bureau has found the act of June 20, 1906, for the protection of the sponge fisheries unenforceable in all of its provisions. The purpose of this law was to protect the sponges off the coast of Florida outside of territorial jurisdiction by preventing diving for them at all times in certain depths of water, and at certain times in all depths, and to prevent the taking, by whatever means, outside of the 3 mile limit, of sponges less than 4 inches in diameter. The offenses at which the act was aimed are not specifically prohibited, but they were supposed to be prevented by the prohibition of certain subsidiary acts—the landing, curing, or offering for sale in the United States of sponges taken in contravention of the real purpose of the law. To secure a conviction it is therefore necessary to establish a connection between (1) the act of taking under the objectionable circumstances and (2) certain subsequent and secondary acts which in themselves are innocuous. A diving vessel operating during the close season can not be interfered with until the sponges are landed, cured, or offered for sale in the United States. The sponges, therefore, must be followed or traced from their beds in the high seas to a point of territorial jurisdiction, a requirement which it is usually impossible to satisfy.

Acting through customs officers of the Treasury Department, various arrests of persons and seizures of vessels and sponges have been made, but no convictions have been secured except in one lot of cases in which the accused pleaded guilty and took appeals which have not yet been brought to issue. In these the evidence on which the prosecution based its action was the sworn statement of the master of each vessel, in which the facts necessary for conviction were admitted. After this experience the masters of the sponging vessels have refused to make further admissions of this character and no other sufficient evidence is obtainable, as the terms of the law are such that no further seizures or arrests can be made unless the offenders again furnish evidence against themselves.

The various defects already referred to were called to the attention of Congress, and on July 12, 1912, the Senate passed a bill (S. 6385) designed to correct them. Opposition to this measure developed among certain persons interested in the sponge fishery, and the House Committee on Merchant Marine and Fisheries conducted a hearing on the subject on August 1, 1912, since which time no action has been taken.

Efforts to enforce the law have continued, but the Bureau is now confronted with an opinion of the Solicitor of the Department holding that while the Secretary is empowered to direct the agents of the Department to perform such duties, not inconsistent with law, as may be necessary to enforce the provisions of the act, he is not authorized to direct them to make arrests or seizures. As the law can not be

enforced without making arrests and seizures, the act of June 20, 1906, which fails to provide authority for such powers, is inadequate in that respect, in addition to its other defects.

The present situation in respect to the law is regrettable, not only on account of its failure to protect the sponge fisheries, but also from the fact that it is being openly flouted and there is being developed among a foreign population, a considerable proportion of which is seeking and attaining citizenship, a contempt for the laws of the land.

The law should be so amended as to make it enforceable, or it should be promptly repealed. The latter course would be regrettable because of the large interests involved in the sponge fisheries and the valuable product whose unnecessary destruction would thereby be condoned and facilitated.

MISCELLANEOUS ACTIVITIES AND RELATIONS OF THE BUREAU.

NEW STATIONS AND LABORATORIES.

The fish-cultural station in Jefferson County, Ky., authorized by Congress in 1911, has been located at Louisville, and 20 acres of land adjoining the State Fair Grounds were donated by the State of Kentucky for the purpose by a deed dated November 6, 1912. Construction work was delayed by floods, but was finally begun the latter part of February, 1913, and at the close of the fiscal year excellent progress had been made. The water supply for ponds and hatchery is from two wells 8 inches in diameter which have been sunk to a depth of 100 feet, in addition to which there is a well 60 feet deep for domestic purposes.

Plans for suitable pump houses have been prepared and the contract for their construction has been let. It is proposed to equip the wells with two electrically driven pumps each having a capacity of over 600 gallons per minute. A steel water tower and tank have been contracted for, several ponds have been excavated, and nearly all the supply and drain pipes have been laid. A dwelling for the superintendent has been completed at a cost of $5,958. This is a two-story, eight-room building with attic and cellar, heated with hot water.

For the fish-cultural station in South Carolina, authorized in 1911, 50 acres of land were purchased for $3,000 in December, 1912, near Orangeburg, a town somewhat south of the center of the State on the Southern and Atlantic Coast Line Railways. The tract contains several natural ponds, and the water supply is derived from springs. Construction work was begun the latter part of May, 1913, and by the end of the fiscal year the excavation of ponds was well under way, and plans had been prepared for the necessary buildings.

The Bureau has as yet been unable to acquire title to the site selected for the new hatching station near Saratoga, Wyo., for which Congress made provision in 1911.

The laboratory building at the Fairport, Iowa, station has been completed. It is a two-story, frame building with basement and attic, and contains 36 rooms. In addition to the various laboratory and office rooms, there are bedrooms, dining room, and kitchen for the use of investigators while temporarily on duty at the station. Three steam turbine-driven centrifugal pumps have been installed, having an aggregate of 75 horsepower, and discharging 2,300 gallons of water per minute against heads varying from 60 to 167 feet.

At the Homer, Minn., and Leadville, Colo., stations small cottages have been erected, and at Homer a contract has been let for a road across the station grounds connecting with the county highway.

At Birdsview, Wash., a new salmon hatchery 40 by 84 feet, of frame construction, was built for $2,663. The hatchery contains 52 troughs and has a capacity of 8,000,000 eggs. Darrington, Wash., has been selected as a site for an additional auxiliary salmon hatchery, but delay has been experienced in acquiring title to the property.

Final selection of a point for the biological laboratory on the Gulf coast of Florida has not been made. Various localities have been examined, and every effort will be put forth to obtain a site that will fulfil all the requirements of a marine station.

The sundry civil bill approved June 23, 1913, contained provision for two new fish-cultural stations —one in Rhode Island, the other in Utah.

PUBLICATIONS.

During the year the following pamphlets were published by the Bureau, besides the monthly statements of fishery products landed at Gloucester and Boston:

Some hydroids of Beaufort, North Carolina. By C. McLean Fraser. Bulletin, vol. xxx, 1910, p. 337–388, 52 text fig. 1912.

Preliminary examination of halibut fishing grounds of the Pacific coast. By A. B. Alexander. With introductory notes on the halibut fishery, by H. B. Joyce. 56 p. 1912.

Notes on a new species of flatfish from off the coast of New England. By W. C. Kendall. Bulletin, vol. xxx, 1910, p. 389–394, pl. LVII. 1912.

Mussel resources of the Holston and Clinch Rivers in eastern Tennessee. By R. E. Coker. 1912.

Alaska fisheries and fur industries in 1911. B. W. Evermann, Chief of Alaska Fisheries Service. 98 p. 1912.

Age at maturity of the Pacific coast salmon of the genus Oncorhynchus. By C. H. Gilbert. Bulletin, vol. XXXII, 1912, p. 1–22, pl. I–XVII. 1913.

A new species of trout from Lake Tahoe. By John O. Snyder. Bulletin, vol. XXXII, 1912, p. 23–28. 1912.

Condition and extent of the natural oyster beds and barren bottoms of Mississippi Sound, Alabama. By H. F. Moore. 61 p., 5 pl., 1 chart. 1913.

The distribution of fish and fish eggs during the fiscal year 1912. 108 p. 1913.
Identification of the glochidia of fresh-water mussels. By Thaddeus Surber. 10 p., 3 pl., 1912.
Report of the Commissioner of Fisheries for the fiscal year ended June 30, 1912. 69 p. 1913.
Description of a new darter from Maryland. By Lewis Radcliffe and William W. Welsh. Bulletin, vol. xxxii, 1912, p. 29–32, pl. xviii. 1913.
Condition and extent of the natural oyster grounds and barren bottoms of Mississippi east of Biloxi. By H. F. Moore. 41 p., 6 pl., 1 chart. 1913.
The sense of smell in fishes. By G. H. Parker and R. E. Sheldon. Bulletin, vol. xxxii, 1912, p. 33–46. 1913.
The fishes of Monterey Bay and tributaries. By John O. Snyder. Bulletin, vol. xxxii, 1912, p. 47–72, pl. xix–xxiv, 3 text fig. 1913.
Anatomy and histology of the alimentary tract of the king salmon. By Charles W. Greene. Bulletin, vol. xxxii, 1912, p. 73–100, pl. xxv–xxviii. 1913.
Notes on the natural hosts of fresh-water mussels. By Thaddeus Surber. Bulletin, vol. xxxii, 1912, 101–116, pl. xxix–xxxi, 1 text fig. 1913.

A new series of publications has lately been inaugurated under the title "Economic circulars," with independent serial numbers. These circulars are the medium for brief advance reports upon investigations, to be more fully treated in subsequent papers, and also for timely information not requiring more lengthy treatment. Often the subject matter will be of interest to certain industries or localities only, and for this reason the economic circulars will not be distributed to addresses upon the regular and permanent mailing lists but to special lists or upon individual request.

APPROPRIATIONS.

The total of appropriations for the Bureau for the fiscal year 1913 amounted to $944,790, as follows:

Salaries	$390,790
Miscellaneous expenses:	
Administration	10,000
Propagation of food fishes	335,000
Inquiry respecting food fishes	40,000
Statistical inquiry	7,500
Maintenance of vessels	60,000
Alaska Fisheries Service	90,000
Beam-trawl investigation	5,000
Protection of sponge fisheries	3,500
Preparation of reports on fisheries of the Philippine Islands	3,000
Total	944,790

An itemized statement of expenditures authorized by the foregoing appropriation has been made as required by law.

FISHERY MATTERS IN CONGRESS.

An act to create a legislative assembly in the Territory of Alaska approved August 24, 1912, contained a special provision denying to the legislature any authority to alter, amend, modify, or repeal any laws of the United States applicable to Alaska affecting fish, game, fur seals, or other fur-bearing animals. Notwithstanding this prohibition, the legislature, at its first session beginning in March, 1913, considered various fishery bills, and even passed a measure increasing the tax on canned salmon, one half this revenue to be for Territorial uses, the other for conservation of the fisheries under direction of the Bureau of Fisheries.

An act to give effect to the convention between the Governments of the United States, Great Britain, Japan, and Russia, for preservation and protection of the fur seals and sea otter which frequent the waters of the North Pacific Ocean, concluded in Washington, July 7, 1911, passed Congress and was approved August 24, 1912. An important provision of this act is the establishment of a five-year close season on the Pribilof Islands, during which time all killing of seals is prohibited except for the food purposes of the natives.

EXECUTIVE ORDERS AND PROCLAMATIONS AFFECTING THE FISHERIES.

Satisfactory information having been received that the Governments of Great Britain, Japan, and Russia had taken the necessary steps to give effect to the first article of the convention concluded July 11, 1911, for the preservation and protection of fur seals and sea otter in the North Pacific Ocean, the President, on May 31, 1913, issued the following proclamation:

Whereas, by the first article of the Convention between the Governments of the United States, Great Britain, Japan and Russia for the preservation and protection of the fur seals and sea otter which frequent the waters of the North Pacific Ocean, concluded at Washington July seventh, nineteen hundred and eleven, it is provided as follows:

The High Contracting Parties mutually and reciprocally agree that their citizens and subjects respectively, and all persons subject to their laws and treaties, and their vessels, shall be prohibited, while this Convention remains in force, from engaging in pelagic sealing in the waters of the North Pacific Ocean, north of the thirtieth parallel of north latitude and including the Seas of Bering, Kamchatka, Okhotsk and Japan, and that every such person and vessel offending against such prohibition may be seized, except within the territorial jurisdiction of one of the other Powers, and detained by the naval or other duly commissioned officers of any of the Parties to this Convention, to be delivered as soon as practicable to an authorized official of their own nation at the nearest point to the place of seizure, or elsewhere as may be mutually agreed upon; and that the authorities of the nation to which such person or vessel belongs alone shall have jurisdiction to try the offense and impose the penalties for the same; and that the witnesses and proofs necessary to establish the offense, so far as they are under the control of any of the Parties to this Convention, shall also be

furnished with all reasonable promptitude to the proper authorities having jurisdiction to try the offense;

And, whereas, by an Act entitled "An Act to give effect to the Convention between the Governments of the United States, Great Britain, Japan and Russia for the preservation and protection of the fur seals and sea otter which frequent the waters of the North Pacific Ocean, concluded at Washington July seventh, nineteen hundred and eleven," approved August 24, 1912, it is provided that the President of the United States shall determine by proclamation when the other parties to said Convention, by appropriate legislation or otherwise, shall have authorized the naval or other officers of the United States, duly commissioned and instructed by the President to that end to arrest, detain, and deliver to the proper officers of such parties, vessels and subjects under their jurisdiction, offending against said Convention or any statute or regulation made by those Governments to enforce said Convention; and that his determination shall be conclusive upon the question;

Now, therefore, I, Woodrow Wilson, President of the United States of America, by virtue of the power and authority conferred upon me by the said Act approved August 24, 1912, do hereby declare that satisfactory information has been received by me that the Governments of Great Britain, Japan and Russia have authorized the naval or other officers of the United States to arrest, detain, and deliver to the proper officers of such Governments, respectively, all persons and vessels subject to their jurisdiction, offending against said Convention, or against any statute or regulation made by those Governments to enforce its provisions; and I do further declare that from and after the date of this Proclamation any person or vessel subject to the jurisdiction of the United States offending or being about to offend against the prohibitions of said Convention, or of said Act, or of the regulations made thereunder, may be seized and detained by the naval or other duly commissioned officers of any of the parties to the said Convention other than the United States, except within the territorial jurisdiction of one of the other of said parties, on condition, however, that such person or vessel so seized and detained shall be delivered as soon as practicable at the nearest point to the place of seizure, with the witnesses and proofs necessary to establish the offenses so far as they are under the control of such party, to the proper official of the United States, whose courts alone shall have jurisdiction to try the offense and impose the penalties for the same.

By an Executive order dated March 3, 1913, the islands of the entire Aleutian Chain, Alaska, were reserved and set apart as a preserve and breeding ground for native birds, for the propagation of fur-bearing animals, and for the encouragement and development of the fisheries. Jurisdiction over the wild birds, game and fur-bearing animals was placed with the Department of Agriculture, and jurisdiction over the fisheries, seals, sea otter, cetaceans, and other aquatic species with the Department of Commerce.

PERMANENT INTERNATIONAL COUNCIL FOR EXPLORATION OF THE SEA.

The eleventh annual session of the Permanent International Council for the Exploration of the Sea was held in Copenhagen, Denmark, in September, 1912. All of the affiliated countries were represented by delegates and experts, and the United States for the first time had official connection with the council. The participation of this country was regarded as one of the leading features of the meeting, and much satisfaction was expressed that the United States

had entered into cooperative study of the Atlantic Ocean in the interests of the fishing industry. One full session of the council was devoted to a discussion of the special investigations that might be carried on by the United States and of the valuable results that might be expected from the coordination of fishery work on the two sides of the North Atlantic. The subject was considered also at the meetings of the various sections into which the council is naturally divided.

At the concluding session of the council, formal resolutions were passed with reference to the special lines of biological and physical research that are desirable on the North American coasts by way of supplement to the work already done on the west coast of Europe. The cooperative investigations recommended for the United States have direct relation to problems now receiving the attention of the council, some of which (as, for example, the variation in the abundance of the common mackerel) are of great interest in America at the present time, while others (such as the biological and economic effects of trawl-net fishing) are certain to be most important to us in the near future.

Occasion having arisen for the election of a new president of the council, the unanimous choice of the delegates was Geheimrat Fritz Rose, vice president of the council and president of the semiofficial Deutsche See-Fischerei Verein. In the reorganization of the executive body of the council, the matter of the representation of the United States thereon was brought up. In view of the recent adhesion of this country to the membership and the difficulty of sending delegates to attend the purely business meetings, the United States delegate advised that, for the present, no position on the executive board was desired. Ultimately, however, it will become necessary for the United States, as one of the great fishing nations in this affiliation, to assume its share of responsibility and labor connected with the administration of the business affairs of the council.

In view of the various and diverse subjects that come before the council at the meetings of the sections devoted to hydrographic, planktonic, and fishery investigations, it is impossible for one delegate adequately to represent the United States and to derive the proper benefit from participation in the meetings. It is therefore important that hereafter the United States have two delegates in attendance, and thus conform with the practice of the other nations.

SOME NEEDS OF THE SERVICE.

NEW OFFICE BUILDING, WITH LABORATORIES AND PUBLIC AQUARIUM.

The present office building of the Bureau of Fisheries is entirely unsuitable for the purpose, being antiquated, overcrowded, and insanitary. The office and laboratory accommodations impede the

transaction of business and retard development along several important lines. Whether or not the Bureau is provided with administrative offices in a general department building or in a special structure in close proximity to the parent headquarters is immaterial. There are urgently needed, however, peculiar laboratory accommoations, a model hatchery equipment, and aquarium facilities which can not be afforded in a large department building; and incidental thereto there should be provided a national aquarium, which can be maintained at minimum cost as an essential part of the experimental work of the Bureau in the study of water animals and of fish-culture methods.

A LOBSTER-REARING PLANT.

More than 10 years ago the Bureau, with the aid of a special appropriation from Congress, devised and carried to a successful stage of perfection a feasible method of rearing lobsters. This work was undertaken in the well-founded belief that lobster culture would and should be made more effective by carrying the newly hatched young beyond the helpless free-swimming age to the point where they develop their crushing claws, go to the bottom, and assume the form and habits of the adults.

The Government has never made any use of the knowledge thus acquired, but the State of Rhode Island, continuing the experimental work, has achieved marked success and has demonstrated the practicality of the method when employed on a large scale.

As an aid to an industry that is in a critical state, it is recommended that Congress be asked to provide for a lobster-rearing station, either as an independent plant or as an adjunct of one of the existing marine hatcheries of the Bureau. For this purpose a sum not exceeding $20,000 would be required for construction and for operating expenses for one year. No facilities for holding and rearing young lobsters now exist at any of the established stations.

STATE COOPERATION.

With the increasing activity in all branches of the fisheries there exists increasing need for active cooperative endeavor on the part of the States to make more effective the work of artificial propagation as carried on under Federal and State auspices. There can be no question that a large amount of such work is now rendered entirely futile by the lack of cooperation or the total indifference of the States. Attention is drawn elsewhere to the great damage that is being done to the shad and alewife fisheries on the Atlantic coast by failure to enact and enforce suitable protective laws. The cases of other fisheries similarly neglected might be cited.

It may well be questioned whether the Bureau is justified in spending money in behalf of the artificial propagation of certain fishes in

certain waters when there is every reason to believe that the expenditures are for the most part utterly wasted. The situation demands the attention of Congress and the adoption of a definite policy to meet the case. The question arises whether the Federal Government should not insist, as a condition of continued Government aid in behalf of the State fisheries, on an amount of protection for the fishes cultivated that common sense shows to be necessary for the maintenance of the supply. The alternative course would seem to be the assumption of Federal jurisdiction over migratory fishes and fishes in interstate waters.

A FISHERIES RESEARCH LABORATORY ON THE PACIFIC COAST.

The Bureau now has two laboratories on the Atlantic coast, one in the Mississippi Valley, and one authorized on the Gulf of Mexico for the scientific and practical investigation of problems relating to the fisheries. On the Pacific coast it is unprovided with laboratory facilities, and it is felt that this deficiency should be corrected as speedily as possible.

The fisheries of the Pacific coast, including Alaska, are valued at upward of $22,000,000, and their products are of such character as to enter into consumption in all parts of the country. There are many potential products which are not yet utilized for lack of definite information concerning their qualities and merits, and there are others the handling of which can be greatly improved. The Bureau believes that if it were provided with the equipment needed for practical investigation and experiment it could increase the volume, improve the quality, and cheapen the cost of the yield of these important fisheries and at the same time lower the price to the consumer.

This form of aid to the fishing industry is believed to be a strictly pertinent function of the Federal Government, and the early establishment of an up-to-date research station is strongly advocated.

INCREASED FACILITIES FOR ALASKA FISHERIES SERVICE.

The attention of Congress has been drawn by the Secretary, in deficiency and regular estimates submitted on behalf of the Bureau, to the urgent need for additional men and vessels to enforce the Alaska fishery laws and to make inspections and investigations on which to base recommendations for new laws, new regulations, or amendments to existing laws. To properly carry out the duties imposed by Congress there should be a thorough patrol of the fishing districts of Alaska each season by agents of the Bureau. This involves travel along 25,000 miles of shore, and necessitates a considerable addition to the present force of men and a number of small vessels by means of which the agents may be transported from fishery to fishery without being under the necessity, as at present, of being

entirely dependent on the favor of the fishery operators. The minimum requirements in this respect have been embodied in estimates for the fiscal year 1915, and favorable action thereon by Congress would seem to be demanded by the great magnitude of the interests at stake.

RELIEF FROM INCONGRUOUS DUTIES.

It is recommended that the Secretary take under consideration the advisability of appealing to Congress for relief from the necessity of administering the laws and regulations affecting the fur-bearing animals of the Territory of Alaska. This subject is not even remotely related to the legitimate functions of the Bureau of Fisheries, but comes naturally under the jurisdiction of another Government bureau. The continued administration of this incongruous service with the absurdly small and inexperienced force allowed by Congress is not only imposing on the Bureau an uncongenial duty, which it is not equipped to perform, but is distracting and diverting much attention that belongs to and is required by the fishing industry.

This recommendation does not apply to the aquatic animals whose pursuit constitutes a "fishery," but only to the strictly terrestrial mammals.

A FISHERY EXPERIMENT STATION.

Fish culture has reached a high degree of perfection in the United States, and the magnitude of the operations as a whole leaves little to be desired. There is, however, much room for effective work in fish culture similar to that conducted in animal and plant industry at agricultural experiment stations; and one of the great and growing needs of the service is an experiment station for study of fish diseases and of problems in fish breeding.

The matter of improving the food and game qualities of fishes by selective breeding is a subject to which practically no attention has as yet been given in this country, but the possibilities are alluring and the project is well worthy of support from Congress, in view of the great improvements that have been produced in domestic animals and plants by the application of scientific methods.

The serious aspect of disease among cultivated fishes has frequently been set forth in the Bureau's reports and brought directly to the attention of Congress. An experiment station would no doubt pay for itself every year in the actual money value of fish saved that are now lost at the hatching stations all over the country because of lack of knowledge of the proper means for preventing and curing the various destructive maladies to which domesticated or semi-domesticated fish are liable.

INCREASED AID TO THE SHELLFISH INDUSTRIES.

The oyster fishery of this country is the most valuable fishery in the world, and its yield to the fishermen of approximately $16,000,000 annually is greater than that of the combined fisheries of Norway, which constitute one of that country's greatest assets. Shellfish, including oysters, create more than one-third of the value of aquatic products of the United States, and they afford food of vast importance to the people, yet the aid given to the industry by the Government is far less than that extended in propagating such fishes as black bass, whose chief value is to afford sport and recreation rather than food.

The oyster, and most of the other shellfishes, owing to their peculiar habits and methods of breeding, can not be propagated as are the true fishes. Oyster culture is of necessity a private enterprise, but it presents many difficulties and dangers which the growers are not in a position to combat, for lack of proper knowledge, and this knowledge can not be obtained excepting through investigations and experiments which the Government alone is in a position to conduct.

The Bureau is without the means, and particularly the personnel, to carry on this much-needed work, although the deficiency and the necessity which it creates have been repeatedly pointed out in these reports and in the estimates for appropriations.

Those interested in the oyster fishery in particular have repeatedly pointed out, with justice, the difference between the lack of consideration which is accorded their industry and the assistance which is received by agricultural interests. Farmers encountering difficulty find help available, but the oystermen laboring under much greater disadvantage find it withheld for the reason that the Bureau has not been provided with the means for extending it. In all justice and for the very practical consideration that our food supplies should be increased and assured, this condition should be corrected without further delay.

Respectfully,

H. M. Smith,
Commissioner.

To Hon. William C. Redfield,
Secretary of Commerce.

THE DISTRIBUTION OF FISH AND FISH EGGS DURING THE FISCAL YEAR 1913

ROBERT S. JOHNSON
Assistant in Charge of Fish Culture

Appendix I to the Report of the Commissioner of Fisheries for 1913

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THE DISTRIBUTION OF FISH AND FISH EGGS DURING THE FISCAL YEAR 1913.

CHARACTER OF THE WORK.

More than 95 per cent of the output of the fish-cultural stations consists of important commercial species, notably the salmons, shad, whitefish, pike perch, yellow perch, white perch, lake trout, cod, pollock, haddock, flatfish, and lobsters. These are hatched in lots of many millions annually and planted by the Bureau, the fresh-water species principally in the large coastal streams and in the Great Lakes, the marine species upon the inshore fishing grounds of the Atlantic.

The cultivation of the fishes of the interior waters, generally classed as game fishes, although a comparatively small factor in the total output, is a very important feature of the Bureau's work, supplying as it does various kinds of young fish for public streams, lakes, and ponds, fishing preserves, private ponds, private streams, etc., in all parts of the United States. Among the fishes most extensively produced for these purposes are several species of trout, the grayling, the basses, crappies, bream, and catfishes; various others also are handled.

The trouts and other species of Salmonidæ, whose eggs can be artificially manipulated, are produced in adequate numbers. The black basses and allied species are not susceptible to artificial propagation, and for its supplies of such fishes the Bureau must depend largely upon the natural reproduction of brood fish held in ponds prepared for the purpose. This supply is far short of the demand. During the early stages of their existence young bass in ponds are exposed to dangers of many kinds. Snakes, frogs, turtles, various water insects, fish-eating birds, amphibious animals, all are destructive to the fry, while the larger specimens of young of the same school prey upon their weaker brethren.

The degree of success attained in this work is also governed largely by the state of the weather and other natural conditions beyond the control of the Bureau. Located as they are, along the shoal pond margins, the nests receive the full effect of atmospheric changes. A sudden fall in temperature will often cause the parent fish to desert their nests, and the eggs and young, being extremely sensitive, are frequently killed by the cold or their development retarded. Another unfavorable feature connected with the location of the nests in shallow water is that they are subjected to the full force of surface

drainage and washings following heavy rains. Roily water is exceedingly injurious to the ova and young of the black bass, and as heavy rains and sudden temperature changes are conditions which must be expected during the season of the year when these fishes spawn, the results of the Bureau's pond-cultural operations are hazardous and uncertain in the extreme. One year a station may have a good output, and the next year, apparently under similar conditions, very few young fish will be produced. What has been said regarding the difficulties met with in black bass culture applies with equal force to the crappies, sunfishes, catfishes, and the rock bass.

With its present facilities the Bureau would be quite powerless to cope with the situation, so far as the demands for the pond fishes are concerned, were it not for the valuable fields afforded for rescue work by the overflow of certain rivers to which these fishes are indigenous. These rivers periodically overflow their banks, the flood waters covering many thousands of acres of the adjacent lowlands. During this flood period, which occurs when the river fishes are spawning, they seek the quiet overflow waters to deposit their eggs. Before the fry hatched from these eggs have become strong, the receding waters cut off their return to the main channels, and thus many thousands of young bass and other fishes are imprisoned in land-locked waters, where they would eventually and inevitably perish from drought or cold unless removed. For a number of years past the Bureau has been collecting young fishes from these temporary lakes and ponds, returning a liberal percentage of them to the original streams, and utilizing the surplus for distribution to applicants and for stocking public waters in various sections of the country.

METHOD OF DISTRIBUTION.

The first consideration in the Bureau's distribution of fishes is to make ample return to the waters from which eggs or fish have been collected. The remainder of the product is consigned to suitable public or private waters upon application indorsed by a United States Senator or Representative, the Bureau furnishing to persons interested an application blank for this purpose. The blank calls for a description of the waters to be stocked, and by this information is determined the species of fish that is suitable and the number that may be allotted to the water area in question. Certain predaceous species, such as the basses and perches, are not furnished for waters inhabited by trout or other valuable fishes to which they would be destructive. Nor, of course, are species like trout and salmon furnished for waters already stocked with fish that would prey upon them.

The fish are carried to their destination in railroad cars equipped for the purpose or by messengers who accompany the shipments in

baggage cars, and are delivered to the applicant free of charge, at the railroad station nearest the point of deposit. The applicant is advised by telegraph when the shipment will arrive and is expected to make due provision for care of the fish until planted. Definite instructions in this respect are furnished at the time of shipment.

During the past fiscal year (July 1, 1912, to June 30, 1913) the Bureau received 10,284 applications for fish, and a very large per cent of them were for the basses, crappies, sunfishes, and catfishes, for stocking artificial ponds on farms.

The difficulties and uncertainties encountered in the production of such fishes make it impossible for the Bureau to fill applications for them as promptly as those calling for the fishes propagated by the artificial manipulation of their eggs. It is the policy of the Bureau to fill all applications in the order in which they are received and to arrange for the delivery of the fish as soon as practicable thereafter.

SIZE OF FISH WHEN DISTRIBUTED.

Fishes are distributed at various stages of development, according to the species, the numbers in the hatcheries, and the facilities for rearing. The commercial fishes—such as the shad, whitefish, lake trout, pike perch, cod, etc., hatched in lots of many millions—are necessarily planted as fry shortly after hatching. Atlantic salmon, landlocked salmon, and various species of trout are reared, in such numbers as the hatchery facilities permit, to fingerlings from 1 to 6 inches in length; the remainder are distributed as fry.[a]

The basses, bream, and other sunfishes are distributed from some three weeks after they are hatched until they are several months of age. When the last lots are shipped the basses usually range from 4 to 6 inches and the sunfishes from 2 to 4 inches in length. The numerous fishes collected in overflow lands—basses, crappie, sunfishes, catfishes, yellow perch, and others—are 2 to 6 inches in length when taken and distributed.

Eggs are distributed only to State hatcheries and, occasionally, to applicants who have hatchery facilities.

SIZE OF ALLOTMENTS.

The Bureau does not attempt to furnish to any one applicant more than a brood stock of fish for a given private pond or stream, it being expected that these will be protected until they have had

[a] The varying usage in the classification of young fish as to size has caused such confusion and difficulty that the Bureau has adopted uniform definitions, as follows:

Fry=fish up to the time the yolk sac is absorbed and feeding begins.

Advanced fry=fish from the end of the fry period until they have reached a length of 1 inch.

Fingerlings=fish between the length of 1 inch and the yearling stage, the various sizes to be designated as follows: No. 1, a fish 1 inch in length and up to 2 inches; no. 2, a fish 2 inches in length and up to 3 inches; no. 3, a fish 3 inches in length and up to 4 inches, etc.

Yearlings=fish that are 1 year old, but less than 2 years old from the date of hatching; these may be designated no. 1, no. 2, no. 3, etc., after the plan prescribed for fingerlings.

time to reproduce. The number of fish in an allotment is, however, a variable quantity, depending upon the species and the age at which distributed. Brook trout, which are distributed both as fry and fingerlings, are allotted in much larger numbers as fry than as fingerlings 3 or 4 inches long. Pike perch, which, owing to their excessive cannibalism, can not be reared and are consequently distributed as fry, may be supplied in lots of half a million, where an equal water area would receive only 200 or 300 young bass from 2 to 5 inches long. These latter larger fish have a much better chance of reaching maturity than have the fry, and the actual value for stocking purposes of a few hundred fingerling bass may therefore equal many thousand times this number of pike-perch fry.

Owing to the Bureau's inability to produce the black basses, crappies, catfishes, and sunfishes in sufficient numbers to meet the demands, the allotments of such species are necessarily limited to the smallest number needful to form the nucleus for a brood stock for the water area to which assigned.

SPECIES CULTIVATED.

The species handled by the Bureau in 1913 numbered some 50 fishes and the lobster. Of these, the following were artificially propagated:

The catfishes (Siluridæ):
- Horned pout, bullhead, yellow cat (*Ameiurus nebulosus*).
- Marbled cat (*Ameiurus nebulosus marmoratus*).

The suckers and buffalo-fishes (Catostomidæ):
- Small-mouth buffalo-fish (*Ictiobus bubalus*).
- Common buffalo-fish (*Ictiobus cyprinella*).
- Black buffalo-fish (*Ictiobus urus*).

The shads and herrings (Clupeidæ):
- Shad (*Alosa sapidissima*).

The salmons, trouts, whitefishes, etc. (Salmonidæ):
- Common whitefish (*Coregonus albus* and *C. clupeaformis*).
- Lake herring, cisco (*Leucichthys artedi*).
- Chinook salmon, king salmon, quinnat salmon (*Oncorhynchus tschawytscha*).
- Silver salmon, coho (*Oncorhynchus kisutch*).
- Blueback salmon, redfish, sockeye (*Onchorhynchus nerka*).
- Humpback salmon (*Oncorhynchus gorbuscha*).
- Dog salmon (*Oncorhynchus keta*).
- Steelhead trout, hardhead (*Salmo gairdneri*).
- Rainbow trout (*Salmo irideus*).
- Atlantic salmon (*Salmo salar*).
- Landlocked salmon (*Salmo sebago*).
- Blackspotted trouts: Yellowstone Lake trout or cut-throat trout (*Salmo lewisi*); Tahoe trout (*Salmo henshawi*).
- Scotch sea trout (*Salmo trutta*). Introduced species.
- Loch Leven trout (*Salmo trutta levenensis*). Introduced species, propagated in limited numbers for observation.
- Lake trout, Mackinaw trout, longe, togue (*Cristivomer namaycush*).
- Brook trout, speckled trout (*Salvelinus fontinalis*).
- Sunapee trout (*Salvelinus aureolus*).

THE GRAYLINGS (THYMALLIDÆ):
Montana grayling (*Thymallus montanus*).
THE SMELTS (ARGENTINIDÆ):
American smelt (*Osmerus mordax*).
THE BASSES, SUNFISHES, AND CRAPPIES (CENTRARCHIDÆ):
Crappie (*Pomoxis annularis*).
Strawberry bass, calico bass (*Pomoxis sparoides*).
Rock bass, red-eye, goggle-eye (*Ambloplites rupestris*).
Warmouth, goggle-eye (*Chænobryttus gulosus*).
Small-mouth black bass (*Micropterus dolomieu*).
Large-mouth black bass (*Micropterus salmoides*).
Bluegill bream, bluegill sunfish (*Lepomis pallidus*).
Other sunfishes, chiefly *Eupomotis gibbosus*.
THE PERCHES (PERCIDÆ):
Pike perch, wall-eyed pike, yellow pike, blue pike (*Stizostedion vitreum*).
Yellow perch, ring perch (*Perca flavescens*).
THE SEA BASSES (SERRANIDÆ):
Striped bass, rockfish (*Roccus lineatus*).
White perch (*Morone americana*).
THE CODS (GADIDÆ):
Cod (*Gadus callarias*).
Haddock (*Melanogrammus æglefinus*).
Pollock (*Pollachius virens*).
THE FLOUNDERS (PLEURONECTIDÆ):
Winter flounder, American flatfish (*Pseudopleuronectes americanus*).
CRUSTACEANS:
American lobster (*Homarus americanus*).

The fishes rescued from overflowed lands in the Mississippi Basin and returned to the original streams were as follows:

THE CATFISHES (SILURIDÆ):
Spotted cat, blue cat, channel cat (*Ictalurus punctatus*). Only limited numbers obtainable.
Horned pout, bullhead, yellow cat (*Ameiurus nebulosus*).
THE SUCKERS AND BUFFALO-FISHES (CATOSTOMIDÆ):
Small-mouth buffalo-fish (*Ictiobus bubalus*).
Common buffalo-fish (*Ictiobus cyprinella*).
Black buffalo-fish (*Ictiobus urus*).
THE MINNOWS AND CARPS (CYPRINIDÆ):
Carp (*Cyprinus carpio*). Distributed in rare instances on special request and for waters unsuited to other species.
THE PIKES AND PICKERELS (ESOCIDÆ):
Pike (*Esox lucius*). Restored to the streams; not distributed.
Pickerel (*Esox reticulatus*). Restored to the streams; not distributed.
THE BASSES, SUNFISHES, AND CRAPPIES (CENTRARCHIDÆ):
Crappie (*Pomoxis annularis*).
Rock bass, red-eye, goggle-eye (*Ambloplites rupestris*).
Warmouth, goggle-eye (*Chænobryttus gulosus*).
Large-mouth black bass (*Micropterus salmoides*).
Small-mouth black bass (*Micropterus dolomieu*).
Bluegill bream, bluegill sunfish (*Lepomis pallidus*).
Other sunfishes, chiefly *Eupomotis gibbosus*.
THE PERCHES (PERCIDÆ):
Yellow perch, ring perch (*Perca flavescens*).

THE SEA BASSES (SERRANIDÆ):

Yellow bass (*Morone interrupta*).

THE SMELTS (ARGENTINIDÆ):

American smelt (*Osmerus mordax*).

Certain introduced species are propagated to a limited extent, as follows:

THE MINNOWS AND CARPS (CYPRINIDÆ):

Goldfish (*Carassius auratus*). Propagated for ornamental purposes; not distributed.

Ide (*Leuciscus idus*). Cultivated variety, golden ide. Propagated for ornamental purpose; not distributed.

SUMMARIZED STATEMENT OF DISTRIBUTION.

The following table shows the number of eggs and fish actually distributed during the fiscal year 1913, or in other words, the output of the hatcheries with all losses in transportation deducted.

SUMMARY BY SPECIES OF THE DISTRIBUTION OF FISH AND FISH EGGS DURING THE FISCAL YEAR 1913.

Species.	Eggs.	Fry.	Fingerlings, yearlings, and adults.	Total.
Catfish			62,446	62,446
Carp			79,160	79,160
Buffalo-fish		3,080,000	4,212	3,084,212
Shad	3,394,000	133,244,850		136,638,850
Whitefish	73,720,000	393,880,000		467,600,000
Lake herring		4,730,000		4,730,000
Silver salmon	102,000	14,184,283	69,800	14,356,083
Chinook salmon	38,583,873	33,319,423	97,760	72,001,056
Red or sockeye salmon	2,000,000	80,340,902		82,340,902
Humpback salmon		153,680		153,680
Dog salmon		19,479,000		19,479,000
Steelhead trout	980,000	4,300,225	138,410	5,418,635
Rainbow trout	1,106,000	901,370	1,150,957	3,158,327
Atlantic salmon		3,492,464	4,304	3,496,768
Landlocked salmon	224,000	253,546	80,196	557,742
Black-spotted trout	13,305,000	766,950	7,174,060	21,246,010
Loch Leven trout			75,200	75,200
Lake trout	6,612,000	20,594,600	3,024,924	30,231,524
Brook trout	1,239,000	5,280,452	6,014,645	12,534,097
Smelt	4,500,000	1,850,000	27,000	6,377,000
Grayling	903,000	2,613,000		3,516,000
Crappie and strawberry bass			79,279	79,279
Rock bass			64,743	64,743
Warmouth bass			1,390	1,390
Small mouth black bass		234,300	107,641	341,941
Large-mouth black bass		26,250	1,231,052	1,257,302
Sunfish (bream)			203,623	203,623
Pickerel			7,504	7,504
Pike			1,500	1,500
Pike perch	46,200,000	148,510,000		194,710,000
Yellow perch	11,000,000	365,723,000	25,132	376,748,132
Striped bass		7,234,000		7,234,000
White perch	20,000,000	449,120,000	721	469,120,721
Yellow bass			255	255
Cod	6,800,000	221,012,000		227,812,000
Pollock	133,739,000	430,060,000		563,799,000
Haddock	57,868,000	68,257,000		126,125,000
Flatfish		809,270,000		809,270,000
Lobster		199,680,000	200	199,680,200
Total	422,275,873	3,421,591,295	19,726,114	3,863,593,282

Allotments of Fish and Eggs to State Fish Commissions for the Fiscal Year 1913.

State and species.	Eggs.	Fry.	Fingerlings, yearlings, and adults.
California:			
Brook trout	150,000		
Chinook salmon	16,942,873		
Grayling	50,000		
Landlocked salmon	10,000		
Colorado:			
Blackspotted trout	2,000,000		
Connecticut:			
Brook trout	25,000		
Lake trout	50,000		
Yellow perch	5,000,000		
Delaware:			
Black bass			150
Georgia:			
Black bass			2,500
Sunfish			700
Idaho:			
Brook trout			1,650
Maine:			
Brook trout	100,000		
Landlocked salmon	100,000		
Maryland:			
Black bass			600
Massachusetts:			
Catfish			300
Chinook salmon	50,000		
Pike perch	4,000,000		
White perch	15,000,000		
Yellow perch	5,000,000		
Michigan:			
Grayling	50,000		
Lake trout	3,000,000		
Pike perch	41,700,000		
Yellow perch		3,500,000	
Minnesota:			
Lake trout	500,000		
Landlocked salmon	10,000		
Steelhead trout	100,000		
Missouri:			
Rainbow trout			37,800
Montana:			
Blackspotted trout	2,038,500		
Brook trout	200,000		
Grayling	588,000		
Rainbow trout	50,000		
Whitefish	3,000,000		
Nevada:			
Brook trout	50,000		
Rainbow trout	50,000		
Silver salmon	100,000		
New Hampshire:			
Chinook salmon			7,900
Steelhead trout	75,000		
New Jersey:			
Landlocked salmon	8,000		
Rainbow trout	50,000		
Steelhead trout	100,000		
White perch		2,000,000	
Yellow perch		2,000,000	
North Dakota:			
Steelhead trout	200,000		
Ohio:			
Whitefish	19,280,000		
Oregon:			
Blackspotted trout	625,000		
Sockeye salmon	2,000,000		
Brook trout	300,000		
Chinook salmon	21,491,000		
Rainbow trout	380,000		
Pennsylvania:			
Lake trout	100,000		
Whitefish	40,900,000		
Utah:			
Brook trout			12,000
Catfish			72
Small-mouth black bass			160

ALLOTMENTS OF FISH AND EGGS TO STATE FISH COMMISSIONS FOR THE FISCAL YEAR 1913—Continued.

State and species.	Eggs.	Fry.	Fingerlings, yearlings, and adults.
Vermont:			
Brook trout		50,000	
Lake trout	150,000		
Landlocked salmon	10,000		
Steelhead trout	30,000		
Washington:			
Blackspotted trout	400,000		
Steelhead trout	200,000		
Wisconsin:			
Lake trout	2,500,000		
Whitefish	5,000,000		
Wyoming:			
Black bass			60
Blackspotted trout	2,200,000		
Brook trout	225,000		500
Grayling	50,000		
Lake trout	50,000		2,000
Rainbow trout	148,000		
Steelhead trout	100,000		
Total	196,506,373	7,550,000	66,452

SHIPMENT OF EGGS TO FOREIGN COUNTRIES DURING THE FISCAL YEAR 1913.

Country.	Species.	Eggs.	Country.	Species.	Eggs.
British Columbia	Whitefish	5,000,000	India	Rainbow trout	10,000
Canada	Brook trout	150,000	Japan	Rainbow trout	250,000
Do	Steelhead trout	100,000			
Germany	Rainbow trout	100,000	Total		5,610,000

DETAILS OF OUTPUT FOR 1913.

The more generally favorable weather conditions prevailing in 1913 during the spawning season of the commercial species, and the improved quality of the eggs collected as a consequence thereof, enabled the Bureau to increase its output of fish and eggs over that of 1912 by 175,672,225, or 4.76 per cent, notwithstanding the fact that the number of eggs collected exceeded by only 54,543,843, or 1 per cent, the collections of 1912. The species produced in larger numbers in 1913 included haddock, pollock, the silver, chinook, and dog salmons, Atlantic salmon, brook, blackspotted, lake, and Loch Leven trouts, buffalo-fish, grayling, striped bass, large-mouth black bass, whitefish, and white perch.

The following table shows the work of the different stations in 1913, the period of operation, and the eggs and fish delivered by each station for distribution. It will be noted that transfers of fish and eggs from station to station are frequent, serving economy and convenience in transportation where the shipment consists of eggs, and giving advantageous distribution centers in the case of young fish.

STATIONS OPERATED AND THE OUTPUT OF EACH FOR THE FISCAL YEAR 1913.

Station and period of operation.	Species.	Output.			Total.
		Eggs.	Fry.	Fingerlings, yearlings, and adults.	
Afognak, Alaska:					
Entire year	Red salmon		12,551,102		12,551,102
	Humpback salmon		151,800		151,800
	Silver salmon		214,000		214,000
Baird, Cal.: [a]					
Entire year	Chinook salmon	495,275	2,195,100		2,690,375
Battle Creek, Cal.:					
Nov.–Jan.	Chinook salmon	6,270,540			6,270,540
Hornbrook, Cal.: [a]					
Feb.–May	Rainbow trout	833,000	86,580		919,580
	Silver salmon	100,000	17,320		117,320
Mill Creek, Cal.: [a]					
Dec.–Feb.	Chinook salmon	10,327,058			10,327,058
Baker Lake, Wash.:					
Entire year	Sockeye salmon		5,559,000		5,559,000
	Chinook salmon		18,600		18,600
	Silver salmon		2,076,000		2,076,000
	Steelhead trout		12,400		12,400
Birdsview, Wash.: [a]					
Entire year	Blueback salmon		192,700		192,700
	Chinook salmon		5,800		5,800
	Dog salmon		211,300		211,300
	Humpback salmon		1,880		1,880
	Silver salmon	2,000	4,211,407		4,213,407
	Steelhead trout	780,000	499,000		1,279,000
Darrington, Wash.:					
Entire year	Dog salmon		9,886,000		9,886,000
	Chinook salmon		547,500		547,500
	Silver salmon		600,200		600,200
	Steelhead trout		114,000		114,000
Duckabush, Wash.: [a]					
Entire year	Chinook salmon		5,550		5,550
	Dog salmon		5,831,000		5,831,000
	Silver salmon		45,000		45,000
	Steelhead trout	200,000	258,000		458,000
Illabott, Wash.: [a]					
Entire year	Chinook salmon		131,450		131,450
	Dog salmon		197,700		197,700
	Silver salmon		1,618,010		1,618,010
	Steelhead trout		73,050		73,050
Quilcene, Wash.:					
Entire year	Dog salmon		3,353,000		3,353,000
	Silver salmon		230,500		230,500
	Steelhead trout		34,000		34,000
Sultan, Wash.:					
Entire year	Chinook salmon		145,000		145,000
	Silver salmon		1,973,500		1,973,500
	Steelhead trout		486,700		486,700
Battery, Md.:					
Apr.–May	Shad		5,831,850		5,831,850
	White perch	20,000,000	445,850,000		465,850,000
	Yellow perch		229,360,000		229,360,000
Boothbay Harbor, Me.:					
Entire year	Cod		5,611,000		5,611,000
	Flatfish		413,961,000		413,961,000
	Haddock		22,967,000		22,967,000
	Lobster		186,000,000	200	186,000,200
Bozeman, Mont.:					
Entire year	Blackspotted trout		24,000	1,642,360	1,666,360
	Brook trout			390,615	390,615
	Grayling	903,000	2,613,000		3,516,000
	Lake trout			11,200	11,200
	Rainbow trout	230,000	215,800	59,500	505,300
	Steelhead trout			34,200	34,200
Yellowstone, Wyo.: [a]					
July–Aug.	Blackspotted trout	13,305,000			13,305,000

[a] For convenience in handling, transfers were made as follows:
Baird to Central Station, 20,000 chinook salmon eggs.
Hornbrook to Manchester, 10,000 rainbow trout eggs; to Clackamas, 23,700 rainbow trout eggs.
Mill Creek to Baird, 2,000,000 Chinook salmon eggs.
Birdsview to St. Johnsbury, 100,000 silver salmon eggs, and 100,000 steelhead trout eggs; to Duluth, 50,000 steelhead trout eggs; to Nashua, 100,000 steelhead trout eggs; to Spearfish, 100,000 steelhead trout eggs.
Duckabush to Quilcene, 2,000,000 dog salmon eggs.
Illabott Creek to Birdsview, 20,000 steelhead trout eggs.
Yellowstone Park to Bozeman, 2,067,000 blackspotted trout eggs; to Leadville, 6,499,000 blackspotted trout eggs; to Spearfish, 3,185,000 blackspotted trout eggs.

STATIONS OPERATED AND THE OUTPUT OF EACH FOR THE FISCAL YEAR 1913—Contd.

Station and period of operation.	Species.	Output.			Total.
		Eggs.	Fry.	Fingerlings, yearlings, and adults.	
Bryans Point, Md.:[a]					
Mar.–May	Shad		28,408,000		28,408,000
	Yellow perch		113,923,000		113,923,000
Cape Vincent, N. Y.:					
Entire year	Brook trout		880,000		880,000
	Lake herring		4,730,000		4,730,000
	Lake trout		3,229,000		3,229,000
	Landlocked salmon		2,400		2,400
	Pike perch		13,800,000		13,800,000
	Rainbow trout		43,000		43,000
	Whitefish		23,900,000		23,900,000
	Yellow perch			220	220
Central Station, Washington, D. C.:[a]					
Entire year	Blass bass			1,600	1,600
	Brook trout		19,400		19,400
	Catfish			2,350	2,350
	Chinook salmon			18,450	18,450
	Crappie			1,345	1,345
	Pike perch		1,400,000		1,400,000
	Rainbow trout		14,390		14,390
	Rock bass			7,000	7,000
	Shad		850,000		850,000
	Small-mouth black bass			3,640	3,640
	Smelt			27,000	27,000
	Sunfish			11,012	11,012
	Warmouth bass			1,115	1,115
	Whitefish		480,000		480,000
	White perch			721	721
	Yellow perch		3,640,000	200	3,640,200
Clackamas, Oreg.:					
Entire year	Brook trout		70,600		70,600
	Chinook salmon		7,121,873		7,121,873
	Rainbow trout		58,649		58,649
Applegate, Oreg.:[a]					
Entire year	Silver salmon		1,468,000		1,468,000
	Steelhead		867,000		867,000
Big White Salmon, Wash.:[a]					
Dec.–Feb	Chinook salmon		13,676,400		13,676,400
Eagle and Tanner Creeks, Oreg.:[a]					
Oct.–June	Chinook salmon	528,000			528,000
	Steelhead trout		25,000		25,000
Little White Salmon, Wash.:[a]					
Entire year	Chinook salmon	19,713,000	5,403,000		25,116,000
Lower Rogue River, Oreg.:					
Entire year	Chinook salmon		537,050		537,050
	Silver salmon		1,730,346		1,730,346
Rogue River, Oreg.:					
Entire year	Black-spotted trout		17,950		17,950
	Chinook salmon	1,250,000	3,532,100		4,782,100
	Rainbow trout		197,000		197,000
	Steelhead trout		1,903,075		1,903,075
Willamette River, Oreg.:					
July–June	Shad		2,566,000		2,566,000
Cold Springs, Ga.:					
Entire year	Black bass		16,500	121,193	137,693
	Carp			400	400
	Catfish			4,954	4,954
	Rock bass			1,050	1,050
	Small-mouth black bass			12	12
	Sunfish			25,770	25,770
	Warmouth bass			125	125
Craig Brook, Me.:[a]					
Entire year	Atlantic salmon		10,000	4,304	14,304
	Brook trout		40,000	28,627	68,627

[a] For convenience in handling, transfers were made as follows:
Bryans Point to Central Station, 3,900,000 yellow perch eggs and 894,000 shad eggs.
Central Station to White Sulphur Springs, 25 small-mouth black bass fingerlings.
Applegate to Rogue River, 1,582,100 steelhead trout eggs.
Big White Salmon to Clackamas, 2,945,000 chinook salmon eggs.
Eagle and Tanner Creeks to Clackamas, 893,000 steelhead trout eggs.
Little White Salmon to Big White Salmon, 4,412,000 chinook salmon eggs.
Craig Brook to Upper Penobscot, 3,616,100 Atlantic salmon eggs.

STATIONS OPERATED AND THE OUTPUT OF EACH FOR THE FISCAL YEAR 1913—Contd.

Station and period of operation.	Species.	Output.			Total.
		Eggs.	Fry.	Fingerlings, yearlings, and adults.	
Craig Brook, Me.—Contd.					
Upper Penobscot, Me.:					
Mar.–May	Atlantic salmon		3,482,464		3,482,464
Duluth, Minn.: [a]					
Entire year	Brook trout			249,000	249,000
	Lake trout	1,100,000	3,815,000	3,010,000	7,925,000
	Landlocked salmon			13,000	13,000
	Pike perch		14,950,000		14,950,000
	Rainbow trout			500	500
	Steelhead trout			49,500	49,500
	Whitefish		16,200,000		16,200,000
Edenton, N. C.:					
Entire year	Black bass			11,235	11,235
	Shad	3,394,000	95,589,000		98,983,000
	White perch		3,270,000		3,270,000
Weldon, N. C.:					
April–May	Striped bass		7,234,000		7,234,000
Erwin, Tenn.: [a]					
Entire year	Black bass			600	600
	Brook trout			168,700	168,700
	Carp			850	850
	Catfish			50	50
	Rainbow trout			295,200	295,200
	Rock bass			1,825	1,825
	Small-mouth black bass			875	875
	Sunfish			13,200	13,200
Gloucester, Mass.: [a]					
Entire year	Cod	6,800,000	105,150,000		111,950,000
	Flatfish		230,070,000		230,070,000
	Haddock	57,868,000	45,290,000		103,158,000
	Lobster		14,480,000		14,480,000
	Pollock	133,739,000	430,060,000		563,799,000
Green Lake, Me.: [a]					
Entire year	Brook trout		1,575,000	65,963	1,640,963
	Lake trout		48,600		48,600
	Landlocked salmon	46,000	160,000	36,200	242,200
	Smelt	4,500,000	1,850,000		6,350,000
Grand Lake Stream, Me.: [a]					
Entire year	Brook trout		1,688		1,688
	Landlocked salmon	178,000	91,146	31,496	300,642
Homer, Minn.: [a]					
Entire year	Black bass			2,570	2,570
	Catfish			1,500	1,500
	Crappie			3,300	3,300
	Rock bass			475	475
	Small-mouth black bass.			450	450
	Sunfish			7,050	7,050
	Yellow perch			350	350
Leadville, Colo.: [a]					
Entire year	Blackspotted trout		725,000	3,738,000	4,463,000
	Brook trout	1,205,000	360,000	2,382,500	3,947,500
	Rainbow trout		154,000	114,000	268,000
Mammoth Spring, Ark.: [a]					
Entire year	Black bass			25,251	25,251
	Buffalo-fish			1,000	1,000
	Catfish			14,515	14,515
	Crappie			3,299	3,299
	Pickerel			7,504	7,504
	Rock bass			3,725	3,725
	Small-mouth black bass.			47,088	47,088
	Sunfish			9,853	9,853

[a] For convenience in handling, transfers were made as follows:

Duluth to Bozeman, 50,000 lake trout eggs; to Spearfish, 30,000 lake trout eggs; to Green Lake, 50,000 lake trout eggs; to Clackamas, 30,000 lake trout eggs.

Erwin to Cold Springs, 5,100 rock bass fingerlings; to Wytheville, 2,500 sunfish fingerlings.

Gloucester to Woods Hole, 9,973,000 pollock eggs and 6,296,000 cod eggs.

Green Lake to Duluth, 15,000 landlocked salmon eggs; to Cape Vincent, 5,000 landlocked salmon eggs.

Grand Lake Stream to St. Johnsbury, 25,000 landlocked salmon eggs; to Green Lake, 60,250 landlocked salmon eggs.

Homer to Central Station, 1,000 sunfish fingerlings.

Leadville to Wytheville, 314,000 brook trout eggs; to Clackamas, 100,000 brook trout eggs; to Northville, 50,000 brook trout eggs.

Mammoth Spring to Quincy, 4,715 small-mouth black bass fingerlings; to Tupelo, 3,600 rock bass fingerlings; to Leadville, 1,050 small-mouth black bass fingerlings; to Central Station, 240 small-mouth black bass fingerlings; to Cold Springs, 3,500 small mouth black bass fingerlings.

STATIONS OPERATED AND THE OUTPUT OF EACH FOR THE FISCAL YEAR 1913—Contd.

Station and period of operation.	Species.	Output.			Total.
		Eggs.	Fry.	Fingerlings, yearlings, and adults.	
Mammoth Spring, Ark.—Continued.					
Friar Point, Miss.:[a]					
June	Black bass			7,400	7,400
	Sunfish			1,350	1,350
Manchester, Iowa:[a]					
Entire year	Brook trout	500		873,900	874,400
	Rainbow trout			151,400	151,400
	Rock bass			1,800	1,800
	Small-mouth black bass.			11,200	11,200
Bellevue, Iowa:					
May-Sept	Black bass			27,950	27,950
	Buffalo-fish		80,000		80,000
	Catfish			100	100
	Crappie			7,800	7,800
	Pike			1,500	1,500
	Sunfish			1,000	1,000
North McGregor, Iowa:					
July	Black bass			7,100	7,100
	Catfish			300	300
Nashua, N. H.:					
Entire year	Brook trout		462,000	80,500	542,500
	Chinook salmon			80,500	80,500
	Rainbow trout		41,000		41,000
	Small-mouth black bass.		21,800		21,800
Neosho, Mo.:[a]					
Entire year	Black bass			24,890	24,890
	Carp			145	145
	Crappie			2,235	2,235
	Rainbow trout	33,500		158,210	191,710
	Rock bass			23,548	23,548
	Small-mouth black bass.			1,270	1,270
	Sunfish			19,718	19,718
Northville, Mich.:					
Entire year	Brook trout		527,200	229,500	756,700
	Lake trout	5,512,000	60,000		5,572,000
	Rainbow trout		82,000	7,500	89,500
	Small-mouth black bass.			43,675	43,675
Charlevoix, Mich.:					
Feb.-May	Lake trout		10,444,000		10,444,000
	Whitefish		15,000,000		15,000,000
Detroit, Mich.:[a]					
Entire year	Pike perch	41,700,000	23,000,000		64,700,000
	Whitefish	5,320,000	120,000,000		125,320,000
	Yellow perch		3,500,000		3,500,000
Sault Ste. Marie, Mich.:					
Feb.-May	Lake trout		3,000,000		3,000,000
	Whitefish		21,000,000		21,000,000
Put-in Bay, Ohio:[a]					
Entire year	Pike perch		46,500,000		46,500,000
	Whitefish	68,400,000	197,300,000		265,700,000
	Yellow perch		3,000,000		3,000,000
Quincy, Ill.:[a]					
Entire year	Black bass			261,948	261,948
	Buffalo-fish		3,000,000	3,212	3,003,212
	Carp			77,765	77,765
	Catfish			38,392	38,392
	Crappie			60,325	60,325
	Pike perch		1,400,000		1,400,000
	Rock bass			3,000	3,000
	Sunfish			38,875	38,875
	Yellow bass			255	255
	Yellow perch			25,887	25,887

[a] For convenience in handling, transfers were made as follows:

Friar Point to Mammoth Spring, 5,150 black bass fingerlings and 656 sunfish fingerlings.

Manchester to Quincy, 3,950 rock bass fingerlings; to Duluth, 42,000 rainbow trout eggs; to Homer, 43,000 brook trout eggs and 100 rock bass fingerlings.

Neosho to Quincy, 12,389 rock bass fingerlings and 1,390 small-mouth black bass fingerlings; to Leadville, 300,000 rainbow trout eggs.

Detroit to Central Station, 500,000 whitefish eggs and 7,000,000 pike perch eggs; to Sault Ste. Marie, 20,000,000 whitefish eggs; to Charlevoix, 15,000,000 whitefish eggs; to Duluth, 25,000,000 pike perch eggs; to Quincy, 2,000,000 pike perch eggs.

Put-in-Bay to Duluth, 20,000,000 whitefish eggs; to Cape Vincent, 25,000,000 whitefish eggs.

Quincy to Tupelo, 1,500 yellow perch fingerlings; to Bozeman, 450 sunfish fingerlings, 180 large-mouth black bass fingerlings, 1,300 catfish fingerlings, and 180 crappie fingerlings; to Clackamas, 400 catfish fingerlings, 180 crappie fingerlings and 600 sunfish fingerlings; to Neosho, 8,000 crappie fingerlings; to Northville, 300 catfish fingerlings, 1,200 crappie fingerlings, 150 sunfish fingerlings, and 200 yellow perch fingerlings; to Rosedale, 400 yellow perch fingerlings; to Cold Springs, 1,830 yellow perch fingerlings, 110 large-mouth black bass fingerlings and 2,750 rock bass fingerlings; to Central Station, 400 crappie fingerlings; to Leadville, 225 catfish fingerlings and 750 large-mouth black bass fingerlings.

STATIONS OPERATED AND THE OUTPUT OF EACH FOR THE FISCAL YEAR 1913—Contd.

Station and period of operation.	Species.	Output.			Total.
		Eggs.	Fry.	Fingerlings, yearlings, and adults.	
St. Johnsbury, Vt.: [a]					
Entire year	Brook trout	30,000	1,027,000	140,529	1,197,529
	Lake trout			3,724	3,724
	Rainbow trout		10,351		10,351
	Silver salmon			69,800	69,800
	Small-mouth black bass.		48,500	2,305	50,805
	Steelhead trout		28,000	24,300	52,300
Holden, Vt.: [a]					
Entire year	Brook trout		337,000	121,956	458,956
	Steelhead trout			34,395	34,395
Swanton, Vt.: [a]					
Apr.–May	Pike perch	4,500,000	47,530,000		52,030,000
	Yellow perch	11,000,000	12,300,000		23,300,000
San Marcos, Tex.:					
Entire year	Black bass			646,788	646,788
	Crappie			610	610
	Rock bass			5,100	5,100
	Sunfish			7,750	7,750
Spearfish, S. Dak.:					
Entire year	Black-spotted trout			1,790,000	1,790,000
	Brook trout			618,000	618,000
	Loch Leven trout			75,200	75,200
	Rainbow trout			74,550	74,550
Tupelo, Miss.:					
Entire year	Black bass		11,000	80,253	91,253
	Catfish			800	800
	Crappie			1,335	1,335
	Rock bass			300	300
	Sunfish			70,750	70,750
	Warmouth bass			150	150
Rosedale, Miss.: [a]					
Sept.–Jan	Black bass			340	340
	Crappie			2,210	2,210
White Sulphur Springs, W. Va.: [a]					
Entire year	Black bass			2,642	2,642
	Black-spotted trout			9,700	9,700
	Brook trout	3,500		509,675	513,175
	Rainbow trout	4,500		73,574	78,074
	Small-mouth black bass.		164,000	303	164,303
Woods Hole, Mass.:					
Entire year	Cod		110,251,000		110,251,000
	Flatfish		165,239,000		165,239,000
Wytheville, Va.: [a]					
Entire year	Black bass			13,200	13,200
	Brook trout			172,350	172,350
	Rainbow trout	5,000		219,875	224,875
	Rock bass			17,370	17,370
	Small-mouth black bass.			200	200
	Sunfish			200	200
Yes Bay, Alaska:					
Entire year	Red salmon	2,000,000	62,038,100		64,038,100
Total [b]		422,275,873	3,422,485,381	19,774,171	3,864,535,425

[a] For convenience in handling, transfers were made as follows:
St. Johnsbury to Holden, 601,254 brook trout eggs.
Holden to St. Johnsbury, 525 brook trout fingerlings and 4,550 steelhead trout fingerlings.
Swanton to Cape Vincent, 12,250,000 pike perch eggs.
Rosedale to Tupelo, 1,450 large-mouth black bass fingerlings and 150 crappie fingerlings.
White Sulphur Springs to Central Station, 1,300 brook trout fingerlings, 1,200 rainbow trout fingerlings and 25 small-mouth black bass fingerlings.
Wytheville to Erwin, 1,000 rainbow trout fingerlings and 288,000 rainbow trout eggs; to Cape Vincent, 50,000 rainbow trout eggs; to Central Station, 20,000 rainbow trout eggs; to Northville, 100,000 rainbow trout eggs; to Leadville, 400,000 rainbow trout eggs; to Spearfish, 153,000 rainbow trout eggs; to St. Johnsbury, 50,000 rainbow trout eggs; to Nashua, 75,000 rainbow trout eggs.

[b] Totals show gross output of stations without deducting the following losses in transit: Fry, 894,086; fingerlings, 48,057.

The eggs hatched at the main stations listed in the foregoing table are in many cases obtained from auxiliary sources, usually temporary stations occupied during the season only, or, in some instances, mere camps which are shifted from year to year. In the Great Lakes and off the New England coast collections are made by the Bureau's vessels or boats in favorable localities. The following temporary stations and collecting points furnished eggs of the given species for the main hatcheries during 1913:

List of Egg-Collecting Stations, Fiscal Year 1913.

Station.	Period of operation.	Species handled.
Alaska:		
Eagle Harbor	May 30–June 30	Red salmon.
Uganik Lake	June 11–June 30	Do.
Arkansas:		
Marked Tree	July 1–Sept. 10	Miscellaneous native fish.
Colorado:		
Cheesman Lake	Apr. 10–May 16	Rainbow trout.
Edith Lake	Oct. 15–Nov. 20	Brook trout.
Eldora Lake	Oct. 15–Nov. 18	Do.
Englebrecht Lake	Oct. 9–Nov. 16	Do.
Miklich Lake	Nov. 15–Nov. 23	Do.
Musgroves Lake	Oct. 10–Dec. 2	Do.
Seven Lakes	June 16–July 15	Blackspotted trout.
Smith Ponds	Oct. 26–Dec. 6	Do.
Connecticut:		
Noank	Mar. 8–Mar. 25	Flatfish.
Georgia:		
Harris Pond	Entire year	Catfish and sunfish.
Maine:		
Portland	July 1–Nov. 30 May 5–June 30	Lobster.
Massachusetts:		
Boston	Apr. 20–June 30 Oct. 11–Nov. 15	Do.
Plymouth	Nov. 19–Mar. 25	Cod.
Rockport	Oct. 1–June 30	Lobster.
Sagamore	Nov. 19–Mar. 25	Cod.
Waquoit	Jan. 13–Mar. 25	Flatfish.
Michigan:		
Algonac	May 1–May 21	Pike perch.
Au Sable	Nov. 5–Nov. 9	Lake trout.
Bay City	Mar. 22–May 3	Pike perch and yellow perch.
Belle Isle	Oct. 24–Dec. 10	Whitefish.
Charity Island	Oct. 9–Nov. 30	Do.
Cheboygan	Oct. 18–Nov. 6	Lake trout.
Detour	Oct. 14–Nov. 9	Do.
Fairport	Nov. 1–Nov. 20	Do.
Frankfort	Nov. 6–Nov. 20	Do.
Grand Haven	Nov. 5–Nov. 20	Do.
Great Lake George	Oct. 17–Nov. 16	Whitefish.
Isle Royal	Oct. 14–Nov. 10	Lake trout.
Keweenaw Point	Oct. 6–Oct. 22	Do.
Manistique	Oct. 28–Nov. 21	Do.
Marquette	Oct. 11–Nov. 13	Do.
Monroe Piers	Nov. 1–Dec. 8 Apr. 30	Whitefish and pike perch.
Munising	Oct. 14–Nov. 10	Lake trout.
Ontonagon	....do	Do.
Port Huron	May 3–May 21	Pike perch.
St. James	Nov. 1–Nov. 22	Lake trout.
St. Joseph	Oct. 21–Nov. 20	Do.
Minnesota:		
Grand Marais	Sept. 25–Dec. 3	Do.
Grand Portage	Nov. 5–Dec. 3	Do.
Le Claire Point	July 1–Oct. 5	Sturgeon.
Little Brule	Nov. 11–Dec. 6	Lake trout.
Montana:		
O'Dell Creek	Apr. 1–May 12	Grayling.
Red Rock	May 1–June 30	Do.
South Meadow Creek	Apr. 1–June 26	Grayling and rainbow trout.
New Hampshire:		
Portsmouth	May 1–June 20	Lobster.
New York:		
Mud Creek	Apr. 1–Apr. 30	Pike perch.
Three Mile Bay	November	Whitefish and cisco.

LIST OF EGG-COLLECTING STATIONS, FISCAL YEAR 1913—Continued.

Station.	Period of operation.	Species handled.
Ohio:		
Kellys Island	Nov. 12–Dec. 4	Whitefish.
Middle Bass Island	Nov. 18–Dec. 4	Do.
North Bass	Nov. 12–Dec. 7; Apr. 17–May 8	Whitefish, pike perch, and yellow perch.
Port Clinton	Nov. 10–Dec. 7; Apr. 17–May 8	Whitefish and pike perch.
Toledo	Apr. 7–Apr. 30	Pike perch.
Oregon:		
Eagle Creek	Apr. 1–June 20	Steelhead trout.
Illinois River	Sept. 1–Jan. 1	Chinook and silver salmon.
Upper Clackamas	Entire year	Chinook and silver salmon and steelhead trout.
Rhode Island:		
Wickford	Feb. 19–Mar. 25	Flatfish.
South Dakota:		
Schmidts Lake	Oct. 20–Dec. 20	Brook trout.
Sand Creek	Oct. 20–Jan. 15	Do.
Vermont:		
Darling Pond	July 19–Dec. 6	Do.
Lake Mitchell	Sept. 4–Nov. 30	Do.
Lake Wantastiquet	Sept. 16–Dec. 4	Do.
Orleans	Apr. 16–May 16	Steelhead trout.
Washington:		
Brinnon	October	Silver, dog, and Chinook salmon and steelhead trout.
Elwell Creek	Sept. 11–June 30	Chinook and silver salmon and steelhead trout.
Wyoming:		
Beaver Dam	July 23–July 27	Blackspotted trout.
Clear Creek	July 5–July 27	Do.
Columbine Creek	July 9–July 19	Do.
Cub Creek	July 5–Aug. 20	Do.
Lake Camp	July 1–Sept. 10; June 6–June 30	Do.
Thumb Camp	July 1–Aug. 17; June 12–June 30	Do.

DISTRIBUTION OF FISH AND FISH EGGS, BY LOCALITY AND SPECIES, FISCAL YEAR 1913.

CATFISH.

Disposition.	Fingerlings, yearlings, and adults.
Arkansas:	
Mammoth Spring, Spring River Lakes	600
Many Islands, Spring River	265
Marked Tree, St. Francis River	13,550
Mena, Mena City Lake	100
Colorado:	
Grand Junction, Nelson Lake	200
Stratton, Prairie View Pond	75
Georgia:	
Adairsville, Culberson Pond	100
Avera, Long Branch	100
Barnesville, Wellmaker's pond	100
Bethlehem, Marbles Creek	65
Bremen, East Lake	150
Buena Vista, Bridge Creek	200
Chickamauga, Doty's ponds	125
Clarksville, Beaver Dam Creek	200
College Park, South Lake	200
Comer, South River	100
Crawfordville, Holden's pond	150
Cuthbert, Ellis mill pond	250
Douglasville, Eason pond	150
Upshaw's mill pond	150
Fairburn, Green's pond	50
Hearn's pond	50
Fayetteville, Whitewater mill pond	300
Graysville, Chickamauga Creek	250
Greenville, Tigner's pond	50
Wimbish pond	50
Harris, Bonner's pond	34
Georgia—Continued	
Jefferson, North Oconee River	100
Lafayette, Mahan's pond	100
Lumpkin, Adams's mill pond	300
Hobbs's pond	200
Middleton's pond	100
McDonough, Lowe's pond	75
Manchester, Routon's pond	100
Middleton, Beaver Dam Creek	100
Monroe, Booth's pond	65
Oakwood, Walnut River, branch of	100
Renfroes, Kid Pond	100
Rock Mart, Nichol's pond	100
Temple, Wren's pond	150
Thomson, Harrison's pond	150
Three Notch, Mary Van Bream Pond	150
Trimble, Trimble Pond	100
Warm Springs, Parham's pond	140
Idaho:	
Boise, Shamberger Reservoir	35
Illinois:	
Assumption, Spring Lake	150
Carrollton, Hubbard's pond	200
Decatur, Decatur Club Lake	200
Nicholls Lake	200
Galesburg, Humphreys Lake	200
Hinsdale, Salt Lake	300
Hollidayboro, East Pond	400
Hollidayboro Lakes	400
Joliet, Du Page River	300

DISTRIBUTION OF FISH AND FISH EGGS, BY LOCALITY AND SPECIES, FISCAL YEAR 1913—Continued.

CATFISH—Continued.

Disposition.	Fingerlings, yearlings, and adults.
Illinois—Continued.	
Meredosia, Illinois River	350
Mount Zion, Banton's pond	300
Munster, Swift's pond	300
Oakland, Embarras River	450
Odell, Odell Pond	150
Sandwich, Fox River	300
Watseka, Iroquois River	300
Indiana:	
Angola, Buck Lake	200
Center Lake	200
Chesbro Lake	150
Crooked Lake	200
Gage Lake	200
Golden Lake	200
Howard Lake	150
Lake James	200
Lake Jimerson	150
Loon Lake	150
Silver Lake	200
Snow Lake	200
Boonville, Allendale Lake	100
Brookville, Crystal Pond	100
Charlestown, Beechwood Lake	200
Dugger, Taylor's pond	100
Fairmount, Winston's pond	25
Freetown, Salt Creek	200
Indianapolis, White River	100
Jeffersonville, Burtt's quarry pond	100
Liberty, Whitewater River, East Fork	400
Middletown, Riley's pond	25
Morris, Bischoff's pond	400
Plymouth, Twin Lake	200
Iowa:	
Bussey, Way's pond	100
Coin, Christensen's pond	100
Dyersville, Maquoketa River	400
Earlville, Garrett's mill pond	100
Pleasantville, Van Zee's pond	100
Waterloo, Cedar River	100
Kansas:	
Fort Scott, Fern Lake	200
Scott City, Wilkin's pond	75
Kentucky:	
Beaver Dam, Leach's pond	95
Boyd, Lake Hill	150
Covington, Lubreecht's pond	100
Crofton, Crofton Lake	150
Franklin, McFarland's pond	100
Fulton, Creede's pond	50
Grayson Springs, Harrell's pond	95
Guthrie, Bland's pond	150
Haldeman, Haldeman Reservoir	100
Hyattsville, Hyatts Lake	150
Lebanon, Big Pond	150
Monticello, Swamp Pond	500
Pineville, Clear Creek	300
Stephensburg, Blue Lake	95
Stethton, Blakely's pond	95
Maine:	
Norway, Mud Pond	150
Maryland:	
Bel Air, Finney's ice pond	100
Great Falls, Potomac River	40
Tuxedo, Corridon Pond	100
Massachusetts:	
Boston, Charles River	300
Fitchburg, Whalom Lake	300
Michigan:	
Burr Oak, Hog Lake	375
Cass City, Cass River	200
Edwardsburg, Miller Pond	250
Indian River, Burt Lake	465
Jackson, Portage Lakes	500
Upper Spring Arbor Lake	250
Lakeview, Tamarack Lake	100
Michigan—Continued.	
Manns Siding, Bass Lake	125
Prescott, Mills Lake	250
Mississippi:	
Corinth, Vandiver's lake	200
Prairie, Brand's pond	300
Sessums, Foster's pond	100
Strong, Dream Lake	100
Williams Lake	100
Montana:	
Benton, Johnson Pond	180
Chinook, Hedge Reservoir	180
Galata, Dry Run Reservoir	180
Harlem, Lake Arbo	180
Kalispell, Emmert Lake	180
Nebraska:	
Verdon, Harden's lake	200
Spring Lake	100
New Hampshire:	
Bellows Falls, Connecticut River	450
Manchester, Merrimac River	150
New York:	
Addison, Canisteo River	250
Central Bridge, Schoharie River	250
Collierville, Goodyear Lake	250
Corinth, Bonita Lake	250
Hudson River	250
Palmer Lake	250
Ithaca, Experimental ponds	150
Middletown, Wallkill River	140
Milford, Susquehanna Lake	500
Oneonta, Emmons Lake	250
Ravena, Smith's pond	100
Schenevus, Schenevus Creek	250
Sterlington, Potlake Lake	140
Unadilla, Susquehanna River	250
Walden, Dwaarkill River	140
Wallkill, Dwaarkill River	280
North Carolina:	
Charlotte, Anchor Mill Reservoir	100
Gold Hill, Isenhour Pond	25
Klutt's pond	25
Guilford College, Ash Pond	25
Madison, Beaver Island Pond	25
Dan River	25
Hogans Creek	25
Hogans Pond	15
Matthews, Paddle Pond	150
North Wilkesboro, Mulberry Creek	50
Rockwell, Holshouser's pond	25
Troutman, Norwood Creek	25
Walnut Cove, Dan River	10
Willow Springs, Rowland's pond	25
Ohio:	
Amanda, Crystal Springs Pond	25
Archers Fork, Hille's pond	25
Bidwell, Jones's pond	25
Bradford, Greenville Creek	50
Stillwater River	50
Cambridge, Wills Creek	50
Canfield, Mahoning Lake	200
Carey, Fruth's pond	100
Carthage, Lady of the Woods Lake	200
Columbus, Deer Creek	375
Little Darby Creek	75
Hillsboro, Trimble Lake	100
Lakeside Park, Buckeye Lake	75
Mount Orab, Sterling Pond	100
North Feesburg, Liming's pond	150
Springfield, Broadway Lake	50
Xenia, Hawkin's pond	50
Oklahoma:	
Apache, Chandler Creek	100
Goose Lake	100
Stock Pond	200
Ardmore, City Lake	300

DISTRIBUTION OF FISH AND FISH EGGS, BY LOCALITY AND SPECIES, FISCAL YEAR 1913—Continued.

CATFISH—Continued.

Disposition.	Fingerlings, yearlings, and adults.
Oklahoma—Continued.	
Bison, Baker's pond	100
Boynton, Sunny Lakes	100
Duncan, Cockran's pond	100
Erick, Pearl Lake	100
Fletcher, Crystal Lake	100
Kremlin, Boyd's lake	100
Muskogee, Lieber's pond	100
Pawnee, Lillie's lake	100
Pryor, Radium Creek	100
Stillwater, Pot Pond	100
Stuart, Coal Creek	100
Oregon:	
Albany, Willamette River	100
Clatskanie, Nehalem River	100
Klamath Falls, Lost River	200
Pennsylvania:	
Arcola, Perkiomen Creek	200
Belleville, West Branch Pond	100
Collegeville, Perkiomen Creek	100
Falls, Susquehanna River	300
Goldsboro, Susquehanna River	400
Graters Ford, Perkiomen Creek	100
Greencastle, First Dam Creek	200
Muddy Run	200
Hosensack, Hancock's pond	100
Indian Pond	100
Lancaster, Pequea Creek	300
Malvern, Thomas Pond	100
Marietta, Duffy's pond	100
Norristown, Schuylkill River	100
Oaks, Perkiomen Creek	100
Philadelphia, Fairmount Park Aquarium	100
League Island Park Lakes	300
Rahns, Perkiomen Creek	100
Reedsville, Peachy Dam	100
Spring City, Blackrock Pond	200
Yankee Pond	200
York, Rouse's pond	75
South Dakota:	
Bellefourche, Bellefourche Diversion Dam	200
Bruce, West Lake Oakwood	200
Colome, Choteborsky Lake	100
Colomb Lake	100
Draper, Craig Pond	100
Frost's pond	100
McGilvra's pond	100
Esmond, Esmond Pond	100
South Dakota—Continued.	
Flandreau, Big Sioux River	200
Hamill, Lake Wamblee	300
Kadoka, Washechek's lake	100
Pierre, Winneconjou Pond	100
Sinai, Lake Sinai	200
Tennessee:	
Hampton, Ewing's lake	100
Johnsonville, Story's pond	50
McKenzie, Clear Lake	100
Milan, Ragsdale's pond	50
Nunnelly, Mud Lake	50
Shouns, Johnson's pond	50
Utah:	
Provo, Utah Lake	72
Vermont:	
Brattleboro, Connecticut River	300
Virginia:	
Charlottesville, Mount Eagle Pond	100
Rivanna River	300
West Virginia:	
Benwood Junction, Lake Riedel	150
Berkeley Springs, Cacapon Creek	950
Clarksburg, West Fork Pond	400
Elkins, Tygarts Valley River	300
Grafton, Tygarts Valley River	600
Wells's pond	400
Great Cacapon, Cacapon River	800
Martinsburg, Evans's pond	200
Mill Creek, Crickard's pond	100
Moundsville, Jones's pond	150
Palmer, Holly River	100
Shepherdstown, Potomac River	2,310
Terra Alta, Ashby's pond	200
Villanova, Gillespie's pond	100
Weston, Leggett's pond	100
Wisconsin:	
Eland Junction, Norrie Lake	300
La Crosse, Black River	400
Mississippi River	400
Wyoming:	
Hanna, Troublesome Pond	200
Stephenson Reservoir	200
Hudson, Popoagie River	400
Hulett, Moore's pond	100
Parkman, Northwood Reservoir	100
Rawlins, North Brown Canon Lake	500
Sheridan, Hamm's pond	100
Upton, Piney Reservoir	100
Total [a]	62,446

CARP.

Connecticut:	
Waterbury, Lake Quassapaug	40
Delaware:	
Mount Pleasant, Brick Mill pond	50
Georgia:	
Adrian, Durden's pond	100
Griffin, Experiment Station pond	200
Monroe, Peter's pond	200
Norwood, Bradshaw's pond	200
Sycamore, Green Pond	150
Illinois:	
Meredosia, Illinois River	74,825
Mississippi River	2,000
Iowa:	
Lenox, Krohmer's pond	60
Kentucky:	
Covington, Foltz's pond	100
Woodburn, Hobb's pond	150
Maryland:	
Frederick Road, Springfield Pond	50
Severn, Severn Ponds	80
Massachusetts:	
Boston, exhibition tank	20
North Scituate, Mushquashiat Pond	20
Missouri:	
Neosho, Hearrell Branch	145
New York:	
Mastic, Home Creek	20
North Carolina:	
Marshall, Teague's pond	100
Wilbon, Powell's pond	150
Ohio:	
Holmesville, Burns's pond	150
South Carolina:	
Gramling, Tiger River pond	100
Tennessee:	
Chilhowee, Carpenter's pond	100
Knoxville, Hansley's lake	100
West Virginia:	
Colcord, Meadow Pond	50
Total	79,160

[a] Lost in transit, 515 fingerlings.

DISTRIBUTION OF FISH AND FISH EGGS, BY LOCALITY AND SPECIES, FISCAL YEAR 1913—Continued.

BUFFALO-FISH.

Disposition.	Fry.	Fingerlings, yearlings, and adults.
Arkansas:		
Marked Tree, St. Francis River		1,000
Illinois:		
Belleville, Heinemann's lake		70
Meredosia, Illinois River		300
Meredosia Bay	3,000,000	
Mississippi River		560
Iowa:		
Bellevue, Mississippi River	80,000	
Ohio:		
Port Clinton, Lake Erie		2,250
Pennsylvania:		
Philadelphia, Fairmount Park Aquarium		32
Total	3,080,000	4,212

SHAD.

Disposition.	Eggs.	Fry.
District of Columbia:		
Washington, Potomac River		850,000
Georgia:		
Swainsboro, Little Ohoopee River		300,000
Maryland:		
Broad Creek, Potomac River		1,512,000
Havre de Grace, Chesapeake Bay		5,831,850
Pamunkey Creek, Potomac River		4,213,000
Piscataway Creek, Potomac River		6,029,000
Swan Creek, Potomac River		3,642,000
North Carolina:		
Castle Hayne, North East River		200,000
Comfort, Trent River		400,000
Edenton, Albemarle Sound	3,394,000	91,439,000
Faison, Goshen River		200,000
Fayetteville, Cape Fear River		200,000
Goldsboro, Little River		200,000
Neuse River		200,000
Greensboro, Buffalo Creek		200,000
Ivanhoe, Black River		200,000
Jacksonville, New River		200,000
North Carolina—Contd.		
Maysville, White Oak River		200,000
Newbern, Neuse River		450,000
Pollocksville, Trent River		200,000
Six Runs, Six Runs		300,000
Wallace, North East River		200,000
Washington, Pamlico River		300,000
Wilmington, Cape Fear River		200,000
Virginia:		
Dogue Creek, Potomac River		5,543,000
Hunters Creek, Potomac River		759,000
Little Hunting Creek, Potomac River		1,010,000
Mount Vernon, Potomac River		1,849,000
Occoquan Creek, Potomac River		3,491,000
Pohick, Potomac River		360,000
Oregon:		
Willamette, Willamette River		2,316,000
Washington:		
Arlington, Stilaquamish River		250,000
Total	3,394,000	133,244,850

WHITEFISH.

Disposition.	Eggs.	Fry.
Michigan:		
Ann Arbor, for research work	80,000	
Belle Isle, Detroit River		38,500,000
Lake St. Clair		15,000,000
Caseville, Lake Huron		10,000,000
Detour, Lake Huron		6,000,000
Detroit, Detroit Aquarium	240,000	
Detroit River		45,000,000
Escanaba, Lake Michigan		3,000,000
Fish Island, Lake Superior		1,200,000
Holland, Black Lake		300,000
Indian River, Burt Lake		300,000
Isle Royal, Lake Superior		2,400,000
Manistee, Lake Michigan		400,000
Manistique, Lake Michigan		1,000,000
Marquette, Lake Superior		3,750,000
North Point, Lake Huron		5,000,000
Michigan—Continued.		
Norwood Reef, Lake Michigan		5,000,000
Old Mission Point, Lake Michigan		5,000,000
St. Joseph, Lake Michigan		500,000
Sand Bay, Lake Michigan		5,000,000
Sulphur Island, Lake Huron		5,000,000
Whitefish Point, Lake Superior		11,000,000
Minnesota:		
Duluth, Lake Superior		150,000
Grand Portage, Lake Superior		2,200,000
Ranier, Rainy Lake		500,000
Robbindale, Lower Twin Lake		300,000
Susie Island, Lake Superior		2,400,000

DISRIBUTION OF FISH AND FISH EGGS, BY LOCALITY AND SPECIES, FISCAL YEAR 1913—Continued.

WHITEFISH—Continued.

Disposition.	Eggs.	Fry.
Montana:		
Kalispell, State fish commission	2,000,000	
Somers, State fish commission	1,000,000	
New York:		
Battery Park, New York Aquarium	100,000	
Cape Vincent, Lake Ontario		6,000,000
Fox Island, Lake Ontario		1,500,000
Fuller Bay, Lake Ontario		1,500,000
Grenadier Island, Lake Ontario		7,500,000
Hayes Point, Lake Ontario		1,500,000
Stony Point, Lake Ontario		1,900,000
Syracuse, Oneida Lake		480,000
Tibbitts Point, Lake Ontario		1,000,000
Wilson Bay, Lake Ontario		3,000,000
Ohio:		
Catawba Island, Lake Erie		15,000,000
Cedar Point, Lake Erie		5,000,000
Ohio—Continued.		
Cleveland, State fish commission	19,280,000	
Isle St. George, Lake Erie		20,000,000
Kelleys Island, Lake Erie		45,000,000
Locust Point, Lake Erie		12,300,000
Marblehead, Lake Erie		20,000,000
Middle Bass Island, Lake Erie		30,000,000
Port Clinton, Lake Erie		20,000,000
Put-in-Bay, Lake Erie		20,000,000
Toledo, Lake Erie		10,000,000
Pennsylvania:		
Erie, State fish commission	40,920,000	
Fairmount Park, Fairmount Park Aquarium	100,000	
Wisconsin:		
Madison, State fish commission	5,000,000	
Superior, Lake Superior		3,300,000
British Columbia:		
Victoria, fisheries department	5,000,000	
Total	73,720,000	393,880,000

LAKE HERRING.

Disposition.	Fry.
New York:	
Grenadier Island, Lake Ontario	3,230,000
Hayes Point, Lake Ontario	500,000
Wilson Bay	1,000,000
Total	4,730,000

SILVER SALMON.

Disposition.	Eggs.	Fry.	Fingerlings, yearlings, and adults.
Alaska:			
Afognak, Letnik Lake		214,000	
California:			
Klamath, Klamath River		17,320	
Maine:			
Brownsville, Pleasant River			45,800
Grindstone, Penobscot River			24,000
Nevada:			
Carson City, State fish commission	50,000		
Verdi, State fish commission	50,000		
New York:			
Battery Park, New York Aquarium	2,000		
Oregon:			
Applegate, Applegate Creek		1,468,000	
Grants Pass, Rogue River		1,730,346	
Washington:			
Baker Lake, Baker Lake		2,076,000	
Birdsview, Day Creek		35,000	
Grandy Creek		2,931,407	
Phinney Creek		35,000	
Skagit River		1,210,000	
Darrington, Bennetts Slough		600,200	
Duckabush, Duckabush River		45,000	
Illabott, Illabott Creek		1,618,010	
Quilcene, Little Quilcene River		57,000	
Big Quilcene River		173,500	
Sultan, Elwell Creek		1,973,500	
Total	102,000	14,184,283	69,800

DISTRIBUTION OF FISH AND FISH EGGS, BY LOCALITY AND SPECIES, FISCAL YEAR 1913—Continued.

CHINOOK SALMON.

Disposition.	Eggs.	Fry.	Fingerlings yearlings, and adults.
California:			
Baird, McCloud River		2,195,100	
Brookdale, State fish commission	300,000		
Sacramento, State fish commission	600,000		
San Francisco, State fish commission	1,500,000		
Sisson, State fish commission	14,522,873		
Truckee, State fish commission	20,000		
Massachusetts:			
Wilkinsonville, State fish commission	50,000		
New Hampshire:			
Blodgetts Landing, Lake Sunapee			30,000
Laconia, State fish commission			7,900
Newbury, Lake Sunapee			41,410
New York:			
Arden, Applicant	100,000		
Forest Lake			18,450
Oregon:			
Bonneville, State fish commission	21,491,000		
Clackamas, Clackamas River		7,121,873	
Grants Pass, Rogue River		537,050	
Rogue River, Rogue River		157,100	
Trail, Rogue River		3,475,000	
Washington:			
Baker, Baker Lake		18,600	
Big White Salmon		2,950,000	
Columbia River		4,550,000	
Spring Creek		6,076,400	
Birdsview, Skagit River		5,800	
Darrington, Bennetts Slough		447,500	
Skagit River		100,000	
Duckabush, Duckabush River		5,550	
Illabott, Illabott Creek		131,450	
Little White Salmon, Little White Salmon River		5,403,000	
Sultan, Elwell Creek		145,000	
Total [a]	38,583,873	33,319,423	97,760

[a] Lost in transit, 1,190 fingerlings.

RED OR SOCKEYE SALMON.

Disposition.	Eggs.	Fry.
Alaska:		
Afognak, Letnik Bay		12,551,102
Yes Bay, McDonald Lake		28,085,600
Yes River		38,952,500
Oregon:		
Bonneville, State fish commission	2,000,000	
Washington:		
Baker, Baker Lake		5,359,000
Birdsview, Grandy Creek		192,700
Total	2,000,000	80,340,902

HUMPBACK SALMON.

Disposition.	Fry.
Alaska:	
Afognak, Letnik Bay	151,800
Washington:	
Birdsview, Grandy Creek	1,880
Total	153,680

DISTRIBUTION OF FISH AND FISH EGGS, BY LOCALITY AND SPECIES, FISCAL YEAR 1913—Continued.

DOG SALMON.

Disposition.	Fry.
Washington:	
Birdsview, Skagit River	196,300
Grandy Creek	15,000
Darrington, Bennetts Slough	8,005,000
Sauk River	236,000
Skagit River	1,645,000
Duckabush, Duckabush River	5,831,000
Illabott, Illabott Creek	197,700
Quilcene, Big Quilcene River	2,541,000
Little Quilcene River	686,000
Penny Creek	126,000
Total	19,479,000

STEELHEAD TROUT.

Disposition.	Eggs.	Fry.	Fingerlings, yearlings, and adults.
Michigan:			
Watersmeet, Henderson Creek			6,000
Minnesota:			
Duluth, Lester River			7,000
French River, French River			7,000
St. Paul, State fish commission	100,000		
Montana:			
Harlowton, Fish Creek			8,000
Lebo Creek			8,000
Musselshell River			8,000
Manhattan, Spring Creek			2,500
Roundup, Parrot Creek			800
Sheridan, Lower Branham Lake			1,200
Upper Branham Lake			1,200
Twodot, Musselshell River			2,000
Wilsall, Shields River			2,500
New Hampshire:			
Laconia, State fish commission	75,000		
New Jersey:			
Hackettstown, State fish commission	100,000		
New York:			
Raquette Lake, applicant	50,000		
North Dakota:			
Grand Forks, applicant	25,000		
Mercer, Brush Lake			4,750
St. Johns, Gravel Lake			4,000
State fish commission	200,000		
Oregon:			
Applegate, Applegate Creek		867,000	
Eagle Creek, Eagle Creek		25,000	
Trail, Red Blanket Creek		15,000	
Rogue River		1,888,075	
Vermont:			
Barton, Barton River		18,000	6,950
Greensboro, Caspian Lake		10,000	5,260
Hardwick, East Long Pond			1,000
Marshfield, Niggerhead Pond			8,750
Winooski River			7,500
Montpelier, Dog River			8,750
Newport, Clyde River			1,900
Orleans, Willoughby River			17,350
Roxbury, State fish commission	30,000		
Washington:			
Arlington, Lake Armstrong		15,000	
Baker, Baker Lake		12,400	
Billingham, Good Lake		15,000	
Squalicum Lake		15,000	
Birdsview, Grandy Creek		175,000	
Skagit River		139,000	
Creston, Wilson Creek		15,000	
Darrington, Bennetts Slough		114,000	
Duckabush, Duckabush River		258,000	
Dupont, Sequalchee Lake		15,000	
Ferndale, Lake Terrill		15,000	
Illabott, Illabott Creek		73,050	

DISTRIBUTION OF FISH AND FISH EGGS, BY LOCALITY AND SPECIES, FISCAL YEAR 1913—Continued.

STEELHEAD TROUT—Continued.

Disposition.	Eggs.	Fry.	Fingerlings, yearlings, and adults.
Washington—Continued.			
Mineral, Mineral Lake		15,000	
Round Top Creek		10,000	
North Yakima, Nelson Spring Creek		15,000	
Port Angeles, Elwha River		15,000	
Quilcene, Big Quilcene River		34,000	
Seattle, State fish commission	100,000		
Sultan, Elwell Creek		486,700	
Walla Walla, State fish commission	100,000		
Wenatchee, Entiat River		20,000	
Lake Chelan		20,000	
Wisconsin:			
Donaldson, Black Oak Lake			8,000
Iron River, Little Muscallonge Lake			10,000
Wyoming:			
Sheridan, State fish commission	100,000		
Canada:			
Southhampton, Canadian Government	100,000		
Total [a]	980,000	4,300,225	138,410

RAINBOW TROUT.

Arizona:			
Holbrook, Becker's pond			2,000
Kingman, Oak Creek			1,000
Arkansas:			
Gravette, White's pond			5,000
California:			
Bridgeport, Walker River and tributaries			5,000
Hornbrook, Cottonwood Creek		86,580	
Colorado:			
Breckenridge, Spruce Creek		22,900	
Buffalo, Lake Cheeseman			30,000
Colorado Springs, Reservoir No. 5			1,500
Denver, Cherry Vale Trout Ponds			1,000
Leadville, Arkansas River		30,000	15,000
Eagle River		15,000	
Lake Creek		20,000	
Meadow Creek			1,000
Otto Creek			2,000
Rock Creek		25,000	
Savage Lake			4,000
Shippy Pond			1,000
Taylor Creek			3,000
Willow Creek		25,000	
Malta, Eagle River		10,000	
Gore Creek		5,000	
Pueblo, Arkansas River			2,500
Salida, Arkansas River			20,000
England's pond			1,000
Poncha Creek			5,000
South Arkansas River			5,000
Singleton, Singleton Lake			3,000
Connecticut:			
Norfolk, Blackberry River			640
District of Columbia:			
Washington, Aquarium, Central Station			15
Georgia:			
Calhoun, Wright's spring pond			400
Chatsworth, Mill Creek			2,400
Clayton, Kingwood Lake			2,000
Eton, Mill Creek			350
Graysville, Chickamauga Creek			210
Menlo, Ledbetter's pond			140
Ringgold, East Chickamauga Creek			1,000
Illinois:			
Arlington Heights, Kellogg's pond			100
Indiana:			
La Porte, Hoover Creek			600
Mishawaka, Willow Creek			500
Morgantown, Spicer's pond			500

[a] Lost in transit, 3,985 fingerlings.

DISTRIBUTION OF FISH AND FISH EGGS, BY LOCALITY AND SPECIES, FISCAL YEAR 1913—Continued.

RAINBOW TROUT—Continued.

Disposition.	Eggs.	Fry.	Fingerlings, yearlings, and adults.
Iowa:			
Arlington, Brush Creek			1,000
Joy Springs Creek			1,000
Decorah, Bear Creek			1,600
Trout River			16,800
Lansing, Bacon Creek			300
Capoli Creek			300
Cavers Creek			300
Clear Creek			300
Clear Creek, tributary of			300
Delormo Creek			300
French Creek			300
Horseshoe Creek			300
Marquette Creek			300
Roggensack's pond			5,000
Scholtes Creek			300
Thompsons Creek			600
Twin Creeks			300
Nora Springs, Fee's pond			300
North McGregor, Bloody Run			1,200
Crimmons Creek			2,600
Osage, Burr Oak Creek			600
Postville, Smith Spring Brook			300
Yellow River			600
Kentucky:			
Cornettsville, Big Leatherwood Creek			1,500
Farmers, Triplett Creek			1,000
Fullerton, Farley's pond			1,000
Louisville, applicant	500		
Maloneton, Farley's pond			3,000
Mount Sterling, Lulbegrud River			8,000
Versailles, Spring Hill Pond			300
Spring Lake			1,000
Louisiana:			
Minden, Gladney's pond			600
Maryland:			
Chevy Chase, Rock Creek		10,390	
Monkton, Holmes Branch			2,000
Mount Winans, Lakeland Lake			500
Oakland, Big Youghiogheny River			8,000
Browning's pond			200
Lake Ford			900
Muddy Creek			200
White Oak Run			200
Massachusetts:			
Clinton, Tadmore Brook		5,000	
Millbury, Ramshorn Brook		5,000	
Michigan:			
Central, Montreal River, branch of			400
Crystal Falls, Paint River			1,000
Gaylord, Pigeon River		31,000	
Grayling, Tillula Lake			4,000
Indian River, Sturgeon River		20,000	
Mandan, Silver River			200
Phoenix, Garden City River			400
Ravenna, Crockery Creek			4,000
Watersmeet, Henderson Creek			6,000
Wingleton, Pere Marquette River		31,000	
Minnesota:			
Harmony, Odessa Creek			600
Willow Creek			600
Houston, Badger Valley Creek			600
Crystal Valley Creek			600
Dailey Creek			600
Looney Valley Creek			600
Money Creek			600
Story Valley Creek			300
Lanesboro, Duschee Creek			600
Mask Creek			600
Torgeson Creek			600
Watson Creek			600
Park Rapids, Fish Hook Creek			600
Preston, Camp Creek			3,000
Middle Branch			600
Partridge Creek			1,000
Watson Creek			15,000

DISTRIBUTION OF FISH AND FISH EGGS, BY LOCALITY AND SPECIES, FISCAL YEAR 1913—Continued.

RAINBOW TROUT—Continued.

Disposition.	Eggs.	Fry.	Fingerlings, yearlings, and adults.
Minnesota—Continued.			
Stockton, Stockton Creek			400
Stockton Creek, east branch			400
Stockton Creek, west branch			600
Winona, Millers Creek			1,000
Missouri:			
Arlington, Gasconade River			620
Bourbon, Blue Spring Branch			620
Browns Spring, Rainbow Lake			30,000
Chicopee, Current River			800
Dixon, Gasconade River			620
Fanning, Brush Creek			620
Lebanon, Hahatonka Lake			6,000
Niangua River			1,550
Marshfield, James River			310
Osage River			310
Mountain Grove, Bryant Spring Creek			10,000
Neosho, Indian Creek			5,000
Hickory Creek			5,000
Schuler's pond			1,600
Shoal Creek			16,000
White Lake No. 1			550
Newburg, Little Piney River			620
Yancy Mill Lake			2,000
Niangua, Osage Fork River			620
Potosi, applicant	33,000		
Rolla, Gasconade River			775
Little Piney River			775
Little Piney River, upper			2,763
Mill Creek No. 2			1,842
South Spring Creek			921
Yancy Mill Lake			922
St. Clair, Indian Creek			620
St. Joseph, State fish commission			37,800
Thayer, Greer Spring Creek			2,000
Winona, Current River, west fork			800
Montana:			
Anaconda, State fish commission	50,000		
Cascade, Spring Creek		4,000	
Columbus, Armstrong Lake			7,500
Beaver Pond		4,000	
Elk Lake			9,000
Fiddler Creek			6,000
Fulkerson Lake		8,000	
Lower West Rosebud Lake			7,500
Mystic Lake			6,000
Pitchfork Creek			6,000
Spring Creek			4,500
Stillwater River		8,000	
Helena, Chessman Lake		16,000	
Maudlow, Spring Creek			1,000
Norris, Madison Lake		155,000	
O'Dell Creek, O'Dell Creek		20,800	
Nevada:			
Carson City, State fish commission	50,000		
Springdale, Kimball's pond			500
Tecoma, Hoppie Lake			500
New Hampshire:			
Concord, Massassecum Brook		5,000	
Newbury, Lake Sunapee		16,000	
New Jersey:			
Hackettstown, State fish commission	50,000		
Princeton, applicant	4,500		
Salem, Cedar Run			2,500
New York:			
Albany, Glen Lake		5,000	
Battery Park, New York Aquarium	5,000		
Benson Mines, Star Lake		10,000	
Calverton, Peconic River, tributary			560
Callicoon, North Branch			1,000
Gloversville, County Line Lakes		10,000	
Stony Creek			1,500
Hornell, Canisteo River			4,000
Long Lake West, Bear Pond			500
Bettner Ponds			500

DISTRIBUTION OF FISH AND FISH EGGS, BY LOCALITY AND SPECIES, FISCAL YEAR 1913—Continued.

RAINBOW TROUT—Continued.

Disposition.	Eggs.	Fry.	Fingerlings, yearlings, and adults.
New York—Continued.			
Oneonta, Knapp Brook			1,000
Light company pond			2,500
Woods Brook			1,500
Patterson, Croton River			2,500
Tabor Brook			1,500
Portage, Letchworth Park Home Pond		3,000	
Poughkeepsie, Rudco Lake			1,500
Rome, Big Alder Creek		4,000	
Little Alder Creek		4,000	
Point Rock Creek		4,000	
Syracuse, Butternut Creek			375
Limestone Creek			375
Onondaga Creek			375
Pebble Hill Pond		3,000	
Pecks Brook			125
Towners, Croton River, Middle Fork			2,000
North Carolina:			
Asheville, Lake Tahkuostee			1,200
Black Mountain, Swannanoa River, Little Lefthand Fork			2,000
Swannanoa River, Long Branch			2,000
Swannanoa River, North Fork			4,000
Swannanoa River, Randolph Branch			2,000
Swannanoa River, Sugar Fork			2,000
Boonford, Big Crabtree Creek			5,000
South Toe River			6,300
Brevard, Batsons Creek			1,200
Buck Horn Creek			1,200
Bushy Creek			75
Cannon Creek			75
Deer Park Lake			1,275
Dunn's creek			800
Kings Creek			1,350
Nicholson Creek			150
Seniard Lake			2,400
Tuckers Creek			1,200
Williamson's creek			150
Bryson City, Brush Creek			2,100
Marr Creek			1,200
Cherryfield, Cherryfield Creek			150
Conway, Martin's pond			225
Dillsboro, Shell Creek			2,100
Elk Park, Watauga Creek			5,000
Graphiteville, Pritchards Creek			1,000
Hendersonville, Big Hungary Creek			2,000
Clear Creek			1,200
Green River			4,000
Kanuga Creek			1,200
Laurel Fork Creek			1,200
Horse Shoe, Boring Mill Creek			75
Bradleys Creek			75
Mills River			150
Queens Creek			75
Hot Springs, Spring Creek			2,100
Lenoir, Reed's pond			400
Linville Falls, Linville River			8,000
Marion, Armstrong Creek			3,000
Big Buck Creek			6,000
Garden Creek			1,000
Gladys Creek			2,000
Lick Log Creek			2,000
Singe Cat Creek			2,000
Stony Creek			2,400
Morganton, Catawba River, Upper South Fork			4,000
Henry River, North and South Forks			4,000
Old Fort, Bird Creek			1,000
Bird Creek, East Fork			1,000
Bird Creek, Middle Fork			1,000
Catawba River			1,000
Laurel Creek			150
North Cedar Creek			150
South Cedar Creek			150
Taylor Creek			150
Penrose, Clayton's pond			800
Clayton Lake			1,600
Grassey Creek			150

DISTRIBUTION OF FISH AND FISH EGGS, BY LOCALITY AND SPECIES, FISCAL YEAR 1913—Continued.

RAINBOW TROUT—Continued.

Disposition.	Eggs.	Fry.	Fingerlings, yearlings, and adults.
North Carolina—Continued.			
Penrose, Hogshead Creek			1,600
Lake Aikenside			1,200
Laurel Creek			150
Mill Creek			1,600
Pinebluff, Lumber River, tributaries			300
Ronda, Lake Neuchatel			75
Spring Hope, Griffin's pond			2,000
Spruce Pine, Grave Yard Creek			1,200
Sylva, Callowhee Creek			1,800
Lilley Creek			2,100
Tuckaseigee River, branch			3,000
Trivett, Beaver Dam Creek			5,000
Tuxedo, Bats Fork Creek			2,000
Cabin Creek			150
Green River			1,500
Paces Creek			1,200
Rock Creek			1,275
Wehutty, Ducktown Creek			5,000
North Dakota:			
New Salem, Silver Spring Pond			200
Springbrook Pond No. 1			100
St. John, Gravel Lake			500
Ohio:			
Akron, Cuyahoga River			500
Cleveland, Rockledge Brook			1,000
Columbus, Spring Lakes			1,000
Mansfield, Dickson Lake			1,000
Koogles Run			1,000
Rockyford Creek, North Branch			1,500
Washington Courthouse, Walnut Creek			1,000
Oklahoma:			
Enid, Government Park Lake			15,000
Lawton, Rowell Spring Creek			5,000
Oregon:			
Baker, Antone Creek		2,000	
Goose Creek		2,000	
Magoon Lake		2,000	
Pine Creek		2,000	
High Lake		2,000	
Rock Creek		2,000	
Strawberry Lake		2,000	
Ballston, Davidson Lake		2,000	
Bonneville, State fish commission	180,000		
Grants Pass, Bolen Lake		2,925	
Hermiston, Cold Spring Reservoir		2,000	
Klamath Falls, Four Mile Lake		2,850	
Lake of the Woods		2,925	
La Grande, Mill Creek		1,000	
Lakeview, Dog Lake			4,000
Lebanon, South Santian River		4,000	
McCoy, Jenkins Pond		2,000	
Milwaukee, Crystal Lake		1,649	
Oregon City, Buckner Creek		2,000	
Buckner Creek, tributary		1,000	
Molalla River, North Fork		2,000	
Molalla River, South Fork		4,000	
Pine Creek		2,000	
Portland, State fish commission	200,000		
The Dalles, Lost Lake		3,000	
Trail, Elk Creek		100,000	
Rogue River		97,000	
Troutdale, Jackson Run		1,000	
Union, Catenni Creek		2,000	
Wallowa, Minam Lake		2,000	
Yoncalla, Adams Creek		2,000	
Pennsylvania:			
Chambersburg, Birch Creek			2,000
Carbaugh Creek			1,500
Falling Spring Creek, North Branch			5,000
Falling Spring Creek, South Branch			5,000
Hoosic Creek			1,500
Cherry Tree, Killen Run			1,600
Easton, Bushkill Creek			500
Echo Lake, Big Bushkill Creek and tributaries			4,000
Lancaster, Kurtz's run			1,200

DISTRIBUTION OF FISH AND FISH EGGS, BY LOCALITY AND SPECIES, FISCAL YEAR 1913—Continued.

RAINBOW TROUT—Continued.

Disposition.	Eggs.	Fry.	Fingerlings, yearlings, and adults.
Pennsylvania—Continued.			
Lanesboro, Starucca Creek			4,500
Tunkhannock Creek			5,000
Latrobe, Indian Camp Run			200
Kellery Run			200
Lewisburg, Bull Run			1,500
Ligonier, McGinnis Run			4,500
Lorane, Jackson Pond			200
Mill Hall, Columbine Creek			800
Mocanaqua, Novak's pond			300
Monessen, Nash's pond			300
Pottsville, West Creek			2,000
Reading, Wyomissing Creek			4,800
Renovo, Bakers Run			1,200
Benjamin Run			600
Big Run and branches			1,200
Cranberry Run			600
Drurys Run and branches			1,200
Halls Run			600
Hyner Run and branches			900
Paddys Run and branches			500
Young Womans Creek and branches			1,500
Royersford, Birch Run			600
Mingo Creek			1,000
Scranton, Roaring Brook			250
Tamaqua, Keefers Run			400
Lizard Creek			600
Locust Creek			600
Owl Creek			600
Pine Creek			300
Rabbit Run			600
Weldy Run			400
Titusville, Killwell Creek			450
McLaughlin Creek			450
Oil Creek			300
Pine Creek			600
Waynesboro, Pass Run			500
Winburne, Six Mile Run			5,000
Rhode Island:			
West Gloucester, Big Pond		10,000	.....
South Carolina:			
Greenville, Gap Creek			1,600
Oil Camp Creek			2,000
Perry Lake			2,000
Upper Tyger Creek			1,600
River Falls, Devils Fork Creek			1,000
Gap Creek			2,000
Fall Creek			2,000
Little River			1,000
Middle Saluda River			2,000
River View, Cox Creek			150
Middle Saluda River			225
Slick Rock Branch			150
Walhalla, Chattooga River			150
East Devils Fork Creek			150
Little River			1,000
Middle Devils Fork Creek			150
Smeltzer's creek			1,000
Whitewater River			225
West Union, Cane Creek			2,000
South Dakota:			
Buffalo, Jones Creek			3,000
Buffalo Gap, Beaver Creek			750
Colome, Burnt John Creek			600
Elmore, Ice Box Creek			400
Spearfish Creek			1,400
Spearfish Creek, East Fork			300
Faith, Pine Creek			500
Hermosa, Battle Creek			450
Red Earth Creek			450
Hill City, Newton Creek			300
Sheridan Pond			300
Spring Creek			600
Hot Springs, Cascade Creek			300
McIntosh, Stinking Creek			1,000
Nahant, Tilson Creek			300

DISTRIBUTION OF FISH AND FISH EGGS, BY LOCALITY AND SPECIES, FISCAL YEAR 1913—Continued.

RAINBOW TROUT—Continued.

Disposition.	Eggs.	Fry.	Fingerlings, yearlings, and adults.
South Dakota—Continued.			
Rapid City, City Springs Pond			300
Rapid Creek			600
Slate Creek			300
Ree Heights, Meppen's pond			500
Rochford, Castle Creek			600
Little Rapid Creek, North Branch			900
Rapid Creek			900
Rapid Creek, South Branch			750
Silver Creek			600
Savoy, Roberts Pond			400
Spearfish Creek			1,100
Spearfish, Dilton Creek			1,650
Lindley Spring Run			450
Normal Lake			600
Ralph's pond			300
Robinson's lake			400
Schmidt Lake			600
Toomy's spring run			450
Sturgis, Bear Butte Creek			20,900
Boulder Park Pond			900
Frederick's pond			150
Tilford, Big Elk Creek			300
Whitewood, Crow Creek			450
Niva Pond			450
Peterson Pond			450
Tennessee:			
Afton, Moors Creek			2,800
Chilhowee, Adams Creek			5,000
Elizabethton, Doe River			5,000
Elkmont, Jakes Creek			1,600
Little River			4,000
Little River, East Fork			1,600
Little River, West Fork			1,600
Erwin, Dicks Creek			10,500
Martin's creek			6,000
North Indian Creek			33,000
Rock Creek			6,000
South Indian Creek			12,000
Franklin, Big Parketh River			2,000
Lick Creek			6,000
Gray, Cedar Creek			3,000
Greenville, Middle Creek			10,000
Johnson City, Chickasaw Pond			200
Hart's pond			450
Lawrenceburg, Shoal Creek, Beelers Fork			2,000
Limestone, Henley's pond			1,200
Mayland, Cooper Lake			10,000
Shell Creek, Birch Creek			1,200
Sparta, Officer's pond			1,000
Townsend, Cove Creek			1,600
Tarwater's pond			400
Tracy City, Fiery Gizzard Creek			6,800
Utah:			
Ogden, North Ogden Fish Hatchery Pond			1,000
Ogden River, branch of			1,000
Rice Creek			2,000
Wellsville, Darley Creek			1,000
North Field Creek			1,000
Vermont:			
Edgewater, Nigger Head Pond		2,825	.....
Plainfield, Winooski River		4,701	.....
Randolph, White River, Randolph Branch		2,825	.....
Virginia:			
Alleghany, Sweet Springs Creek			1,600
Bedford City, Stony Creek			3,500
Clifton Forge, Wilson's creek			5,000
Covington, Falling Spring Run			1,000
East Radford, Little River			5,000
Elgin, Thornton River			4,000
Fredericksburg, Hess Run			300
Glenita, Clinch River, tributary of			400
Gordonsville, Annandale Pond			1,000
Jordan, Chrystley Run			300
Konarock, South Fork River and tributaries			50,000
La Crosse, Taylor's ice pond			700

DISTRIBUTION OF FISH AND FISH EGGS, BY LOCALITY AND SPECIES, FISCAL YEAR 1913—Continued.

RAINBOW TROUT—Continued.

Disposition.	Eggs.	Fry.	Fingerlings, yearlings, and adults.
Virginia—Continued.			
Laurel Dale, White Top Creek			900
Lynchburg, Reveley's pond			1,000
Manteo, Waltons Fork Creek			5,000
Meadow View, Kestner's pond			100
Millboro, Bubbling Spring Creek			5,000
Mill Creek			5,000
Mount Vernon, George Washington Run		4,000	
Natural Bridge, Cedar Creek			1,000
New Castle, Meadow Creek			500
Sinking Creek			1,900
Pulaski, Peak Creek, North Fork			2,000
Sproul Ponds			1,200
Ray, John's creek			5,000
Rural Retreat, Cripple Creek			3,000
St. Clair, Bluestone River			5,000
Shuff, Rich Creek			200
Trevilians, Rocky Creek			2,500
Vienna, Captain Hickory Creek			700
Wytheville, Walker Pond			1,000
Washington:			
Big Lake, Big Lake			4,000
Collins, Johnson Lake		2,000	
Ritzville, York Lake			3,000
Seattle Long Lake			3,000
Stratford, Round Lake			2,000
West Virginia:			
Bunker Hill, Edgewood Spring Pond			5,000
Charlestown, Elliott's run			2,400
Coalton, Roaring Creek			400
Durbin, Shavers Creek, East Fork			300
Fayette, Wolf Creek			300
Harman, Dove's ponds			650
Hinton, Little Bluestone Creek			5,000
Ingleside, East Pond			200
Kegley, Johnston's pond			100
Marlinton, Greenbrier River			5,000
Martinsburg, Hoke's run			250
Mill Creek			250
Tuscarora Creek			250
Midvale, Elk River, Middle Fork			5,000
Mount Jackson, Cove River			400
Morlan, Shank's pond			150
Piedmont, Potomac River, North Fork			8,000
Pleasant Dale, Laurel Run			300
Raleigh, Beaver Run			8,000
Reedsville, Fields Creek			300
Renick, Big Spring Pond			300
Rippon, Shenandoah River and tributaries			1,200
Spangler, Big Run			500
Elk River			5,000
Ralston Run			500
Tygarts Valley River, Left Fork			800
Windy Run			500
Spring Creek, Culbertson Creek			800
Waiteville, Potts Creek, North Branch			300
Wheeling, State Fair Aquarium			4
White Sulphur Springs, Howard Creek			1,205
William, Schmick Ponds			3,000
Wisconsin:			
Bloomer, Conroy Creek			2,000
Duncan Creek			3,000
Hay Creek			2,000
Blue Mounds, Avangs Creek			3,000
Handels Creek			3,000
McKinleys Creek			3,000
Steyer's creek			2,800
Walnut Hollow Creek			3,000
Boyd, Gustafson Creek			1,000
Hay Creek			2,000
Lutz Creek			1,000
Paint Creek			2,000
Shilts Creek			1,000
Brule, Brule River			1,000
Hoodoo Lake			4,000

DISTRIBUTION OF FISH AND FISH EGGS, BY LOCALITY AND SPECIES, FISCAL YEAR 1913—Continued.

RAINBOW TROUT—Continued.

Disposition.	Eggs.	Fry.	Fingerlings, yearlings, and adults.
Wisconsin—Continued.			
Cashton, Coon Creek			3,700
Centuria, Sargent Pond			200
Chippewa Falls, Duncan Creek			400
Colfax, Bronken Creek			2,200
Eighteen Mile Creek			2,000
Eighteen Mile Creek, North Fork			2,000
Eighteen Mile Creek, South Fork			1,000
Mirror Lake			3,400
Otter Creek			2,000
Pleasant Valley Creek			200
Trout Creek			2,000
Cumberland, Clam River, South Fork of South Fork			1,000
Hay River			3,000
Elroy, Seymour Creek			900
Genoa, Spring Creek			500
Kendall, Lumsden Creek			500
Tunnell Creek			500
Ladysmith, Big Thornapple Creek			600
Little Thornapple Creek			400
Merrill, Blue Lake			3,750
Richland Center, Horse Creek			1,000
Pine River, East Branch			1,000
Stanley, Eau Claire River, North Fork			5,600
Turtle Lake, Turtle Creek			3,000
Westby, Kickapoo River			600
Wyoming:			
Beulah, Boyden's pond			250
Sand Pond			200
Big Horn, Mortensen's pond			600
Lander, Roaring Fork Lakes			200
Laramie, applicant	25,000		
State fish commission	100,000		
Moorcroft, Arch Creek			15,000
Butts Lake			600
Newcastle, Beaver Creek			450
Ranchester, Eaton's pond			300
Wolf Creek			800
Sheridan, Bunny Lake			5,000
Hilman Creek			5,000
State fish commission	48,000		
Sundance, Houston Creek			250
Miller Creek			250
Germany:			
Hamburg, German Government	100,000		
India:			
Calcutta, British Government	10,000		
Japan:			
Tokyo, Imperial Household Department	250,000		
Total [a]	1,106,000	901,370	1,150,957

ATLANTIC SALMON.

Maine:			
Craig Brook, Alamoosook Lake			5
East Orland, Alamoosook Lake			4,299
Kennebunk, Little River		10,000	
Stacyville, Penobscot River		1,400,000	
Upper Penobscot, Penobscot River		2,082,464	
Total		3,492,464	4,304

LANDLOCKED SALMON.

California:			
Sisson, State fish commission	10,000		
Maine:			
Bingham, Pierce River		5,000	
Bodfish Crossing, Midday Pond		5,000	
Bridgton, Highland Lake			1,500

[a] Lost in transit, 1,400 fry and 3,353 fingerlings.

DISTRIBUTION OF FISH AND FISH EGGS, BY LOCALITY AND SPECIES, FISCAL YEAR 1913—Continued.

LANDLOCKED SALMON—Continued.

Disposition.	Eggs.	Fry.	Fingerlings, yearlings, and adults.
Maine—Continued.			
Brooks, Mixer Pond			1,000
Brownfield, Moore Pond			1,500
Bucksport, Upper Patten Pond		10,000	
Deering Junction, Highland Lake			1,500
Farmington, Varnum Pond		5,000	1,400
Franklin, Molasses Lake		5,000	
Fryeburg, Lake Kezar			1,500
Grand Lake Stream, Grand Lake		91,146	31,496
Green Lake, Green Lake		8,000	
Hartland, Great Moose Lake			1,500
Harrington, Schoodic Pond		5,000	
Island Falls, Mattawamkeag Lake		5,000	
Jackman, Clear Water Pond		5,000	
Duncan Lake		5,000	
Enchanted Lake		5,000	
Fish Pond		5,000	
Moose Pond		5,000	
Kineo, Moosehead Lake		20,000	5,000
Kingman, Pleasant Lake			1,800
Newport, Lake Sebasticook			1,500
Norcross, Third Jo Merry Lake			1,500
North Anson, Great Embden Pond			1,000
Lake Embden			1,500
North Belgrade, State fish commission	100,000		
Oakland, East Pond			1,100
Otis, Great Brook		21,000	
Green Lake		21,000	
Phillips Lake, Phillips Lake			1,500
Poland Spring R. R. station, Lower Range Lake			1,500
Presque Isle, Squawpan Lake			1,500
Rand Cove, Schoodic Lake			2,000
Rumford Falls, Howard Lake			1,500
Skowhegan, Wentworth Pond		5,000	
Springvale, Mousam Lake		5,000	
Strong, Sweets Pond			1,200
Tunk Pond, Tunk Pond			1,500
Waldoboro, Kaler Pond		5,000	2,000
Massachusetts:			
Plymouth, applicant	10,000		
Minnesota:			
Ely, Burntside Lake			2,000
Knife River, Echo Lake			4,000
Nine Mile Lake			2,000
Tettegouche Lake			2,000
St. Paul, State fish commission	10,000		
New Hampshire:			
Laconia, Lake Winnesquarm		5,000	
Warner, Lake Winnepaukeet		5,000	
New Jersey:			
Hackettstown, State fish commission	8,000		
New York:			
Battery Park, New York Aquarium	1,000		
Delhi, applicant	20,000		
Long Lake West, applicant	5,000		
South Pond		2,400	
Raquette Lake, applicant	50,000		
Vermont:			
Roxbury, State fish commission	10,000		
Wisconsin:			
Donaldson, Black Oak Lake			2,700
Total[a]	224,000	253,546	80,196

BLACKSPOTTED TROUT.

Colorado:			
Alamosa, Fountain's pond			2,000
Almont, East River			12,000
Taylor River			15,000
Anson, Anson Creek			10,000
Antero, Antero Lake			75,000
Antonito, Conejos River			20,000
La Manga Creek			8,000
Los Pinos Creek			12,000

[a] Lost in transit, 500 fingerlings.

DISTRIBUTION OF FISH AND FISH EGGS, BY LOCALITY AND SPECIES, FISCAL YEAR 1913—Continued.

BLACKSPOTTED TROUT—Continued.

Disposition.	Eggs.	Fry.	Fingerlings, yearlings, and adults.
Colorado—Continued.			
Arkansas Junction, Frying Pan River, North Fork			5,000
Aspen, Castle Creek			15,000
Hunters Creek			12,000
Lincoln Creek			12,000
West Castle Creek			12,000
Willow Creek			10,000
Austin, Surface Creek			12,000
Bear Creek, Bear Creek			10,000
Breckenridge, Blue Creek			10,000
Spruce Creek			5,000
Buena Vista, Chalk Creek			15,000
Cottonwood Lakes			85,000
Middle Cottonwood Creek			8,000
North Cottonwood Creek			8,000
South Cottonwood Creek			10,000
Buffalo, Buffalo Creek			25,000
Cascade, Cascade Creek, North and South Forks			8,000
Cebolla, Gunnison River			150,000
Colorado Springs, Cascade Creek			4,000
Cheyenne Creek			4,000
Colorado Springs Lake			80,000
East Beaver Creek			15,000
Gould Creek			15,000
Middle Beaver Creek			25,000
Reservoir No. 5			70,000
Creede, applicant	500,000		
Little Squaw Creek			8,000
Red Mountain Creek			8,000
Rio Grande			60,000
Trout Creek			8,000
De Beque, Big Creek			10,000
Buzzard Creek			10,000
Grove Creek			10,000
Hawkshurst Creek			10,000
Mesa Creek and tributaries			12,000
Plateau Creek			10,000
Salt Creek			10,000
Del Norte, Francisco Creek			10,000
North Pinos Creek			10,000
Denver, State fish commission	2,000,000		
Dillon, Blue River			75,000
Boulder Creek			5,000
Brush Creek			6,000
Cataract Creek			5,000
Elliott Creek			5,000
Keystone Creek			5,000
Otter Creek			5,000
Pass Creek			5,000
Rock Creek			5,000
Slate Creek			8,000
Slate Creek Lake			6,000
Snake River, North Fork			5,000
Straight Creek			10,000
Durango, Bear Creek			6,000
Cascade Creek			10,000
Lost Trail Creek			8,000
Pole Creek			8,000
Rio Grande			10,000
Ten Mile Creek			5,000
Ute Creek			8,000
Eastonville, Reservoir No. 1			3,000
Fairplay, Crooked Creek			10,000
Four Mile Creek			10,000
Pennsylvania Creek			5,000
Rich Creek			10,000
Sacramento Creek			5,000
South Platte River, Middle Fork			10,000
South Platte River, South Fork			8,000
Twelve Mile Creek			6,000
Florence, Ophir Creek			5,000
South Hardscrabble Creek			8,000
Fraser, Fraser River		12,000	
Frisco, Miners Creek			5,000
North Ten Mile Creek			8,000
West Ten Mile Creek			8,000

DISTRIBUTION OF FISH AND FISH EGGS, BY LOCALITY AND SPECIES, FISCAL YEAR 1913—Continued.

BLACKSPOTTED TROUT—Continued.

Disposition.	Eggs.	Fry.	Fingerlings, yearlings, and adults.
Colorado—Continued.			
Fort Collins, Buckhorn Creek			12,000
Cache La Poudre River			12,000
Cache La Poudre River, North Fork			12,000
Lone Pine Creek			12,000
Granby, Illinois Creek		12,000	
Willow Creek		8,000	
Grand Junction, Kannah Creek			10,000
West Creek			15,000
Grand Lake, Stillwater Creek		10,000	
Granger, Embargo Creek			10,000
Grant, Geneva Creek			30,000
Gypsum, Sweetwater Lake			15,000
Hartsel, Platte River, South Fork			25,000
Hayden, Big Union Creek			12,000
Hill, Hill Creek			5,000
Hotchkiss, Lareux Creek			12,000
Idaho Springs, Chicago Creek, South Fork			5,000
City Lake			5,000
South Beaver Creek			8,000
Ivanhoe, Ivanhoe Creek			17,000
Frying Pan River			25,000
Lyle Creek			5,000
Kokomo, Ten Mile Creek			20,000
Lake George, South Platte River			15,000
Leadville, Arkansas River			135,000
Colorado Gulch Creek			12,000
Crooked Lake		29,000	
Elk Creek		29,000	
Emerald Lake			50,000
Empire Gulch Creek			12,000
Fraser River		93,000	
Frying Pan River			25,000
Grand Lake		80,000	
Grand River		95,000	
Grand River, North Fork		95,000	
Half Moon Creek			27,000
Lake Creek			40,000
Monarch Lake		30,000	
Porcupine Gulch Creek			8,000
Rock Creek			30,000
St. Louis Creek		29,000	
Stillwater Creek		20,000	
Timberline Lake			4,000
Turquoise Lake			100,000
Twin Lakes			100,000
Wheeler Creek		40,000	
Willow Creek		75,000	27,000
Windsor Lake			10,000
Loveland, Cache La Poudre River, South Fork			12,000
Lyons, applicant	400,000		
Malta, Lake Creek, North Fork			12,000
Mancos, West Mancos River			10,000
Marshall, South Boulder Creek			120,000
Mears Junction, Poncha Creek			12,000
Minturn, Cross Creek			15,000
Eagle River			20,000
Gore Creek			15,000
Lake Creek			16,000
Rock Creek			15,000
Willow Creek			15,000
Monte Vista, Alamosa River			15,000
Rock Creek			12,000
Montrose, Big Red Creek			5,000
Clear Creek			5,000
Horsefly Creek			6,000
Montrose, Little Cottonwood Creek			5,000
Little Red Creek			5,000
Roubideaux Creek			6,000
Tabeguache Creek			6,000
Mustang, Graneros Creek			8,000
Greenhorn River			10,000
St. Charles River			10,000
Nast, Frying Pan River			5,000
Frying Pan River, South Fork			5,000
Frying Pan River, Upper South Fork			8,000

DISTRIBUTION OF FISH AND FISH EGGS, BY LOCALITY AND SPECIES, FISCAL YEAR 1913—Continued.

BLACKSPOTTED TROUT—Continued.

Disposition.	Eggs.	Fry.	Fingerlings, yearlings, and adults.
Colorado—Continued.			
New Castle, Divide Creek			12,000
Munson Creek			10,000
West Divide Creek			10,000
Newett, Teeter's pond			3,000
Norrie, Chapmans Creek			15,000
Deeds Creek			5,000
Foster Creek			5,000
Frying Pan River			15,000
Gowen Creek			5,000
Kochs Lake			12,000
West Chapman Creek			6,000
North Cheyenne, North Cheyenne Canyon Creek			8,000
Ouray, Uncompahgre River, East Fork			8,000
Pagosa Springs, Piedra River, East Fork			10,000
Piedra River, Middle Fork			8,000
San Juan River, Beaver Fork of West Fork			6,000
San Juan River, East Fork			8,000
San Juan River, West Fork			8,000
San Juan River, Rainbow Fork of West Fork			6,000
Pando, Eagle River			30,000
Paonia, East Muddy Creek			10,000
Hubbard Creek			10,000
Terror Creek			10,000
West Muddy Creek			10,000
Parlin, Cochetopa Creek			15,000
Parshall, Battle Creek		8,000	
Beaver Creek		10,000	
Grand River		20,000	
Grand River, Williams Fork		12,000	
Grand River, South Fork of Williams Fork		10,000	
Pitkin, Snipe Creek			5,000
Platte Canyon, South Platte River			100,000
Pueblo, Arkansas River			5,000
Rico, Dolores River			10,000
Horse Creek			8,000
Ryman Creek			6,000
Scotch Creek			10,000
Silver Creek			8,000
Ridgway, Trout Lake			20,000
Salida, Arkansas River			150,000
Cochetopa Creek			8,000
Poncha Creek			8,000
Slate Creek			15,000
South Arkansas Creek			8,000
Sargents, Marshall Creek			12,000
Sellar, Frying Pan River, North Fork			5,000
Shawnee, Deer Creek			25,000
Snow Mass, Snow Mass Creek			15,000
South Fork, Alder Creek			10,000
Bear Creek			8,000
Rio Grande River, South Fork			10,000
Sulphide, Middle Boulder Creek			25,000
Sunset, Four Mile Creek			10,000
Tabernash, Meadow Creek		8,000	
Tennessee Pass, West Tennessee Creek			8,000
Trout Lake, Trout Lake			25,000
Villa Grove, Saguache River			20,000
Walcott, Eagle River			50,000
Webster, South Platte River			20,000
Westcliffe, Horn Lake			5,000
Macey Creek			5,000
Whitewater, Kalmah Creek			12,000
North Kalmah Creek			10,000
Youmans, Big Blue Creek			8,000
Big Blue Creek, East Fork			5,000
Fall Creek			5,000
Idaho:			
Coeur d'Alene, Wolf Lodge Creek			10,000
Enaville, Little North Fork Creek			8,000
Fort Hall, Spring Creek			4,000
Malad, Stuart's pond			2,000
Mullan, Wellington Lake			8,000
Rathdrum, Lake Chilco			16,000
Roberts, Seamon's pond			4,000
Spring Creek			2,000
Oxford, Gooseberry Creek			4,000
Grove Lake			4,000

DISTRIBUTION OF FISH AND FISH EGGS, BY LOCALITY AND SPECIES, FISCAL YEAR 1913—Continued.

BLACKSPOTTED TROUT—Continued.

Disposition.	Eggs.	Fry.	Fingerlings, yearlings, and adults.
Michigan:			
Detroit, Detroit Aquarium	25,000		
Montana:			
Anaconda, Josephine Pond			5,000
State fish commission	2,038,500		
Armstead, Barrett Creek			10,000
Briggs Run			4,000
Clarks Canyon Bayou			6,000
Grayling Creek			2,000
Medicine Lodge Creek			12,000
Selway Creek			6,000
Spring Creek			4,000
Wild Rose Lake			6,000
Ballantine, Arrow Creek			7,500
Lake McDonald			20,000
Belt, Little Belt Creek			16,000
Logging Creek			16,000
Pilgrim Creek			16,000
Bozeman, Bear Creek			5,000
Bridger Creek			45,000
Buckskin Creek			12,500
Buffalo Horn Creek			5,000
Camp Creek			25,000
Eight Mile Creek			10,000
Elbow Creek			10,000
Elk Creek			21,000
Meadow Creek			5,000
Middle Creek			30,000
Middle Creek Lakes			25,000
Mill Creek			15,000
Porcupine Creek			4,000
Reese Creek			15,000
South Fork Creek			7,500
Spring Creek		24,000	15,000
Squaw Creek			2,000
Story Creek			15,000
Butte, applicant	256,500		
Fort Benton, Shoukin Creek			20,000
Darby, Bitter Root River, East Fork			12,000
Bitter Root River, West Fork			12,000
Dell, Morrison Lake			6,000
Gardiner, applicant	900,000		
Grannis Siding, Shields River			40,000
Hamilton, Bitter Root River			32,000
Bitter Root River, East Fork			20,000
Blodgett Creek			16,000
Girds Creek			16,000
Lick Creek			16,000
Lost Horse Creek			18,000
Lost Horse Creek, South Fork			16,000
Rock Creek			20,000
Roaring Lion Creek			16,000
Skalkaho Creek			20,000
Sleeping Child Creek			16,000
Haugan, Big Creek			6,000
Josephine, Sixteen Mile Creek			40,000
Lennep, Little Cottonwood Creek			8,000
Lewistown, Antelope Creek			720
Howell Spring Pond			320
Reglis Pond			5,000
Spring Creek			20,000
Waite Spring Pond			320
Lima, Big Sheep Creek			20,000
Little Sheep Creek			14,000
Livingston, Adair Creek			800
Billman Creek			12,000
Fleshman Creek			12,000
Hill Pond			700
Holliday Creek			15,700
Shields River			16,000
Swindlehurst's pond			10,000
Tobin Creek			800
Manhattan, Ellingsen Pond			4,000
Mill Creek, Big Timber Creek			10,000
Boulder Creek			15,000
West Boulder Creek			10,000

DISTRIBUTION OF FISH AND FISH EGGS, BY LOCALITY AND SPECIES, FISCAL YEAR 1913—Continued.

BLACKSPOTTED TROUT—Continued.

Disposition.	Eggs.	Fry.	Fingerlings, yearlings, and adults.
Montana—Continued.			
Missoula, Big Blackfoot River			22,000
Bitter Root River			22,000
Grant Creek			14,000
Grove Creek			12,000
Lo Lo Creek			20,000
Miller Creek			10,000
O'Brien Creek			10,000
Rattlesnake Creek			14,000
Mitchell, Little Prickly Pear Creek			15,000
Monarch, Hoover Creek			10,000
Tillinghast Creek			16,000
Neihart, Belt Creek			20,000
Belt Creek, South Fork			10,000
O'Brien Creek			8,000
Norris, Parent Lake			5,000
St. Regis, St. Regis River			12,000
Superior, Flat Creek			6,000
Wilsall, Daisy Dean Creek			15,000
Elk Creek			20,000
Winston, Sweeney's lake			5,000
Wyola, Little Big Horn River			18,000
Yantic, Clear Creek			16,000
Nebraska:			
Chadron, Chadron Creek			40,000
New Mexico:			
Capitan, Rio Ruidoso			20,000
Carlsbad, Lake Bujac			8,000
Dexter, Lake Durand			4,000
Glorieta, Irving Springs			4,000
Mora River			20,000
Pecos River			40,000
Las Vegas, Gallinas River			20,000
Magdalena, South Diamond Creek			6,000
Tulerosa Creek			10,000
Mountain Air, Barranca River			8,000
Raton, Cimman Point Creek			8,000
Ribera, Pecos River			8,000
Rowe, Pecos River			40,000
Santa Fe, Santa Fe River			15,000
Tesuque River			15,000
Taiban, Taiban Creek			4,000
Thoreau, Cottonwood Creek			8,000
Tres Piedras, San Antonito Creek			10,000
Tusas Creek			6,000
Ute Park, Rio Grande and tributaries			40,000
Wagon Mound, Tilsons Springs			4,000
New York:			
Battery Park, New York Aquarium	25,000		
Oregon:			
Baker, Salmon Creek			6,000
Duncan, Meacham Creek			12,000
Eugene, McKenzie River			38,000
Independence, Berry Creek			6,000
Teal Creek			6,000
Lakeview, Crooked Creek			46,000
Oregon City, Buckner Creek			6,000
Canyon Creek			10,000
Cedar Creek			10,000
Clackamas River			18,000
Deep Creek			10,000
Newell Creek			10,000
Ramsby Creek			6,000
Rock Creek			10,000
Pendleton, Desolation Creek			10,000
Winam Creek			8,000
Portland, Lechler Lake			4,000
State fish commission	625,000		
Tillamook City, Nestucca River			14,000
Trail, Rogue River		17,950	
Yamhill, McCoy Creek			10,000
South Dakota:			
Custer, French Creek			75,000
Iron Creek			35,000
Elmore, Beaver Creek			20,000
Fountain City Creek			20,000
Miller Creek			20,000

DISTRIBUTION OF FISH AND FISH EGGS, BY LOCALITY AND SPECIES, FISCAL YEAR 1913—Continued.

BLACKSPOTTED TROUT—Continued.

Disposition.	Eggs.	Fry.	Fingerlings, yearlings, and adults.
South Dakota—Continued.			
Elmore, Spearfish Creek			85,000
Spearfish Creek, East Fork			10,000
Spearfish Creek, South Fork			20,000
Englewood, Box Elder Lake			6,000
Jim Creek			9,000
Middle Box Elder Creek			6,000
Whitewood Creek			25,000
Fairburn, French Creek			40,000
Faith, Pine Creek			3,000
Hermosa, Lower Spring Creek			30,000
Hill City, Battle Creek			40,000
French Creek			20,000
Spring Creek			50,000
Hot Springs, Cascade Creek			15,000
Iron Creek, Bear Gulch Creek			21,000
Maitland, Blow's pond			2,500
Mystic, Rapid Creek			111,000
Nahant, North Rapid Creek, East Branch			15,000
Pluma, Elk Creek			50,000
Pringle, Cold Spring Creek			15,000
Rapid City, Rapid Creek			40,000
Rochford, Deffenbaugh's pond			6,000
Little Rapid Creek			69,000
Rapid Creek			37,500
Savoy, Spearfish Creek			60,000
Spearfish, Crow Creek			7,500
Iron Creek			20,000
Johnson Creek			40,000
Lost Cabin Creek			4,500
Spearfish Creek			300,000
Spring Gulch Creek			30,000
Sturgis, Alkali Creek			70,000
Tilford, Big Elk Creek			40,000
Washington:			
Bellingham, Canyon Lake			30,000
Curlew, Kettle River			20,000
Heisson, State fish commission	400,000		
Malo, St. Peters Creek			10,000
Orient, Big Boulder Creek			20,000
Republic, Granite Creek			8,000
Seattle, Lake Crescent			30,000
Toroda, Toroda Creek			10,000
White Salmon, Spencer's pond			4,000
Spring Creek Pond			6,000
West Virginia:			
Durbin, Big Run			9,700
Wyoming:			
Beulah, Crystal Spring Pond			34,000
Sand Creek			8,000
Stouts Spring Run			10,000
Cody, Shoshone River, South Fork			25,500
Lander, Baldwin Creek			45,000
Popo Agie Creek			45,000
Squaw Creek			45,000
North Fork Creek			50,000
Lost Springs, Card's ponds			9,000
Slough Pond			3,000
Willow Pond			3,000
Newcastle, Beaver Creek			20,000
Sheridan, State fish commission	2,200,000		
Sundance, South Miller Creek			10,000
Yellowstone National Park, Boat House Creek	725,000		
Cub Creek	400,000		
De Lacy Creek	850,000		
Duck Lake	50,000		
Grebe Lake	300,000		
Hatchery Creek	460,000		
Indian Creek	100,000		
Number Two Creek	400,000		
Soldier Creek	300,000		
Transportation Creek	350,000		
Total [a]	13,305,000	766,950	7,174,060

[a] Lost in transit, 6,000 fingerlings.

DISTRIBUTION OF FISH AND FISH EGGS, BY LOCALITY AND SPECIES, FISCAL YEAR 1913—Continued.

LOCH LEVEN TROUT.

Disposition.	Fingerlings.
South Dakota:	
Savoy, Little Spearfish Creek	75,200

LAKE TROUT.

Disposition.	Eggs.	Fry.	Fingerlings.
Connecticut:			
Hadlyme, State fish commission	50,000		
Idaho:			
Coeur d'Alene, Coeur d'Alene Lake			1,600
Rathrum, Twin Lakes			1,600
Soda Springs, Government Reservoir			1,200
Maine:			
Bryant Pond, Lake Christopher		10,600	
Farmington, Varnum Lake		5,000	
Franklin, Donnell's pond		8,000	
Jackman, Clear Water Pond		5,000	
Onawa, Lake Onawa		10,000	
Michigan:			
Alpena, Lake Huron		964,000	
Atwood Reef, Lake Michigan		1,088,000	
Beulah, Crystal Lake		100,000	
Big Rock Reef, Lake Michigan		4,096,000	
Detour, Lake Huron		1,000,000	
Detroit, Detroit Aquarium	12,000		
State fish commission	3,000,000		
Escanaba, Lake Michigan		300,000	
Fish Island, Lake Superior		480,000	
Fishermans Island, Lake Michigan		960,000	
Fishing Shoals, Lake Superior			420,000
Frankfort, Lake Michigan		100,000	
Isle Royal, Lake Superior		500,000	580,000
Long Point, Lake Superior		480,000	
McCargoes Cove, Lake Superior		480,000	
Marquette, Lake Superior		625,000	
Munising, Lake Superior		625,000	
Nine Mile Point, Lake Michigan		960,000	
Norwood Reef, Lake Michigan		1,088,000	
Ontonagon, Lake Superior		625,000	
Sand Bay Reef, Lake Michigan		1,088,000	
Tobins Harbor, Lake Superior			380,000
West Branch, Loon Lake		58,000	
Whitefish Point, Lake Superior		1,700,000	
Minnesota:			
Duluth, Lake Superior			190,000
Grand Marais, Lake Superior			792,000
Grand Portage, Lake Superior			238,000
St. Paul, State fish commission	500,000		
Stannard Rock, Lake Superior			240,000
New Hampshire:			
Chesham, Silver Lake			477
Laconia, Lake Winnisquam			769
Weirs, Lake Winnepesaukee		10,000	769
New York:			
Carmel, Lake Gleneida		40,000	
Charity Shoals, Lake Ontario		525,000	
Grenadier Island, Lake Ontario		1,050,000	
Fox Island, Lake Ontario		175,000	
Fuller Bay, Lake Ontario		325,000	
Lake Placid, Lake Placid		25,000	
Raquette Lake, applicant	200,000		
Sabattis, applicant	50,000		
Stoney Point, Lake Ontario		660,000	
Wilson Bay, Lake Ontario		429,000	
Pennsylvania:			
Bellefonte, State fish commission	100,000		
Vermont:			
Barnet, Laird Lake			471
Barton, Hartwell Pond			500
Greensboro, Caspian Lake			738
Lyndonville, State fish commission	150,000		

DISTRIBUTION OF FISH AND FISH EGGS, BY LOCALITY AND SPECIES, FISCAL YEAR 1913—Continued.

LAKE TROUT—Continued.

Disposition.	Eggs.	Fry.	Fingerlings.
Washington:			
Newport, Davis Lake			1,600
Nighthawk, Palmer Lake			1,600
Reardan, Little Falls Lake			1,600
Wisconsin:			
Donaldson, Black Oak Lake			50,000
Fifield, Homestead Lake			20,000
Madison, State fish commission	2,500,000		
Phelps, North Long Lake			50,000
Stone Lake, Stone Lake			50,000
Wyoming:			
Sheridan, Kearney Lake			2,000
Story, State fish commission	50,000		
Total [a]	6,612,000	20,594,600	3,024,924

BROOK TROUT.

Disposition.	Eggs.	Fry.	Fingerlings, yearlings, and adults.
Arizona:			
Flagstaff, East Clear Creek			6,400
West Beaver Creek			5,600
Arkansas:			
Hot Springs, Gulfha Creek			2,000
California:			
San Diego, Cedar Creek			4,800
Sisson, State fish commission	150,000		
Colorado:			
Antero, South Platte River			13,000
Antonito, Conejos River and tributaries			20,000
Arkansas Junction, Arkansas River			10,000
Lake Creek			10,000
Tennessee River			10,000
Aspen, Hallams Lake			2,500
Independence Lake			10,000
Maroon Creek			15,000
Maroon Lake			10,000
Meadow Lake			10,000
Taylors Lake			10,000
Weller Lake			10,000
Austin, Dillon Pond			2,000
Baileys, Deer Creek			10,000
South Platte River, North Fork			60,000
Boulder, Gold Lake			10,000
Middle Boulder River			22,000
Buena Vista, Day Pond			6,000
Buffalo, Buffalo Creek			20,000
South Platte River			25,000
Cathers Springs, Little Fountain Creek			15,000
Central City, South Boulder Creek			8,000
Cimarron, Big Blue River			10,000
Big Cimarron River			10,000
Chipeta Creek			10,000
Coal Creek			10,000
Currecanti Creek			10,000
Dago Gulch Creek			10,000
Dry Creek			15,000
Happy Canon Creek			10,000
Little Blue River			10,000
Squaw Creek			10,000
Van Place Lake			8,000
Veo Creek			10,000
Willow Creek			10,000
Colorado Springs, Fursman Lake			6,000
Turkey Creek			5,000
Cotopaxi, Arkansas River		10,000	
Creede, Miners Creek			8,000
Rio Grande River			30,000

[a] Lost in transit, 2,000 fry.

DISTRIBUTION OF FISH AND FISH EGGS, BY LOCALITY AND SPECIES, FISCAL YEAR 1913—Continued.

BROOK TROUT—Continued.

Disposition.	Eggs.	Fry.	Fingerlings, yearlings, and adults.
Colorado—Continued.			
Curtin, Uneva Lake			10,000
Del Norte, Los Pinos Creek, North Fork			10,000
Delta, Alfalfa Creek			4,000
Buttermilk Creek			5,000
East Roubideaux Creek			10,000
Escalante Creek			10,000
Curtis Pond			3,000
Currant Creek			5,000
Doughspoon Creek			5,000
Dry Creek			8,000
Hartford's pond			3,000
Horseshoe Lake			12,000
Kelso Creek			8,000
Lone Star Pond			5,000
Morse's pond			3,000
Parker's pond			3,000
Rinehart's pond			3,000
Vizne Creek			4,000
Ward Creek			5,000
Young's creek			8,000
Dotsero, Gypsum Creek			10,000
Durango, Florida Creek			10,000
Hermosa Creek			10,000
Junction Creek			8,000
Lightner Creek			8,000
Pine River			10,000
Eagle, Brush Creek			20,000
Eastabrook, Craig Creek			15,000
Eldora, Boulder Creek			15,000
Lake Eldora			40,000
Eldorado Springs, South Boulder Creek		10,000	
Empire, Bard Creek			12,000
Clear Creek			12,000
Clear Creek, West Branch			12,000
Florence, Beaver Creek		10,000	
East Beaver Creek		10,000	
Fort Collins, Spring Creek			5,000
Frisco, Excelsior ponds			3,000
Georgetown, Clear Creek, South Branch			11,000
Leavenworth Creek			6,000
Grant, Geneva Creek			10,000
Granite, Lower Twin Lake			20,000
Pine Creek			10,000
Twin Lakes Creek			15,000
Hartsel, South Platte River			15,000
Hillside, North Brush Creek			2,000
Spruce Creek			2,000
Hotchkiss, Clear Fork Creek			8,000
Crystal Creek			8,000
Smiths Fork Creek			10,000
Howard, Arkansas River		15,000	
Idaho Springs, Chicago Lake			16,000
Fall River			10,000
Lake Edith			27,000
Reynolds Lake			6,000
Sherwin Lake			20,000
Slater Lake			6,000
Kremmling, Pass Creek			8,000
Red Dirt Creek			8,000
Lake City, Henson Creek			8,000
Leadville, Arkansas River			22,000
Lake Creek			34,000
Musgrove Lake		20,000	
Savage Lake			10,000
Smith Pond		45,000	
Turquoise Lake			22,000
Tennessee River			12,000
Los Pinos, Los Pinos River, South Branch			10,000
Loveland, Benson's lake			5,000
Malta, Big Thompson Creek	30,000		
Boulder Creek			10,000
Pine Creek			10,000
Meredith, Jakeman Creek			5,000
Minturn, Echo Lake			6,000

DISTRIBUTION OF FISH AND FISH EGGS, BY LOCALITY AND SPECIES, FISCAL YEAR 1913—Continued.

BROOK TROUT—Continued.

Disposition.	Eggs.	Fry.	Fingerlings, yearlings, and adults.
Colorado—Continued.			
Montrose, Cedar Creek			10,000
Cottonwood Creek			10,000
Horsefly Creek			10,000
Mexican Gulch Creek			15,000
Red Canon Creek			10,000
Monte Vista, Rock Creek			8,000
Nast, Frying Pan River			10,000
Frying Pan River, Ivanhoe Branch			15,000
Frying Pan River, South Fork			10,000
Ivanhoe Creek			5,000
New Castle, Adams Lake			10,000
Deep Lake			10,000
Parkdale, Arkansas River		10,000	
Parshall, Bull Run			4,000
Ute Creek			4,000
Pitkin, Armstrong Creek			10,000
North Quartz Creek			8,000
Warm Springs Creek			3,000
Platte Canon, South Platte River			20,000
Pueblo, Arkansas River			3,000
Quinns Spur, Upper Savage Lake			10,000
Ruedi, Beaver Lake			12,000
Rocky Fork Creek			5,000
Saguache, Big Bend Creek			5,000
Long Branch			6,000
Tomichi Creek			10,000
Salida, Arkansas River			60,000
Little Arkansas River			5,000
Miklich's ponds			9,000
Poncha Creek			5,000
Poncha Creek tributaries			8,000
Silver Creek			5,000
Sargents, Tomichi River			15,000
Sloss, Frying Pan River			5,000
South Fork, Rio Grande, South Fork			10,000
Steamboat Springs, Big Creek			8,000
Fish Creek			8,000
Grizzley Creek, North Fork			8,000
Mad Creek Lakes			1,000
Mad Creek, North Fork			8,000
Slater Creek			8,000
Walton Creek			8,000
Whisky Creek and tributaries			8,000
Willow Creek			8,000
Tennessee Pass, Homestake Creek			8,000
Tomasville, Chapman Lake			15,000
Englebrechts Lake			390,000
Lake Howard			11,000
Lime Lake			5,000
Spring Creek			8,000
Wagon Wheel Gap, East Bellows Creek			5,000
Webster, South Platte River			10,000
Wheeler, Black Lake			6,000
West Ten Mile Creek			15,000
Wellington Lake, Wellington Lake			112,000
Woodland Park, Echo Lake			10,000
Hay Creek, North and South Forks			8,000
Long Lake			10,000
Mirror Lake			10,000
Rainbow Lake			10,000
Silver Creek			10,000
Silver Lake			10,000
Yampa, Service Creek			8,000
Connecticut:			
Bridgeport, Far Mill River			1,000
East Canaan, Whiting River			400
East Hampton, Elbow Bridge Brook			300
Green River			300
Sawmill Brook			300
Tartia Brook			300
Forestville, Copper Mine Creek		40,000	
Greenwich, Byram River, East Branch		10,000	
Hartford, West Brook		12,000	300
Jewett City, Broad Brook			300
Hell Hollow Brook			300
Mount Misery Brook			300

DISTRIBUTION OF FISH AND FISH EGGS, BY LOCALITY AND SPECIES, FISCAL YEAR 1913—Continued.

BROOK TROUT—Continued.

Disposition.	Eggs.	Fry.	Fingerlings, yearlings, and adults.
Connecticut—Continued.			
Jewett City, Pratt Brook			300
Robbins Brook			300
Meriden, Highland Lake		30,000	
Pipesdale Brook and tributaries		15,000	
Naugatuck, Great Brook			2,000
New Hartford, Farmington River			400
Norfolk, Pond Hill Pond		30,000	
Norwich, Broad Brook		20,000	
Choates Brook		10,000	
Kimball Brook		10,000	
Pine Meadow, Farmington River, East Branch			4,000
Simsbury, Spring Pond			1,000
Stratton Brook			6,000
Westminster Farm Pond			300
South Norwalk, Calvin Brook		10,000	
Weston River		20,000	
Tariffville, Salmon Brook			3,980
Waterbury, Abbott's brook			1,000
Boughton Brook			1,000
Chestnut Hill Brook			1,000
Dallas Brook			1,000
Giles Brook			1,000
Hancock Brook			1,000
Hop Brook			1,000
Kanes Brook			1,000
Lead Mine Brook			1,000
Lilly Brook			1,000
Linsley Brook			1,000
Loughlin's brook			1,000
Morris Brook			1,000
Osborns Brook			1,000
Pearl Lake		5,000	
Peck's brook			1,000
Pomperaug River			1,000
Rag Hollow Brook			1,000
Roaring Brook		5,000	
Todd Hollow Brook			1,000
Welton Brook			1,000
Welton's pond		5,000	
Hill's brook		5,000	
Hog Brook		5,000	
Long Hill Brook		5,000	
Nichols Brook		5,000	
Ponds Brook		5,000	
Pritchards Pond		5,000	
Shaddrach Brook		5,000	
Snagg Brook		5,000	
Ten Mile Brook		5,000	
Windsor, Mayloo Pond			200
Windsor Locks, State fish commission	25,000		
District of Columbia:			
Washington, Aquarium, Central Station			15
Idaho:			
Athol, Trapper Creek			280
Boise, Spring Lake			600
Dubois, Dry Creek			450
Fort Hall, Spring Creek			1,350
Idaho Falls, Birch Creek			300
Hell Creek			150
Idaho Commercial Trout Co. ponds			300
Indian Creek			300
Willow Creek			450
Malad, Dives Run			300
Hunsaker Pond			300
Meadow Creek, Rock Creek			420
Rigby, Granite Creek			500
Granite Pond			400
Roberts, Crystal Lake			750
Sandpoint, Thompson Pond			200
Summit Siding, Skin Creek			280
Illinois:			
Fox, Crystal Spring Pond			300
Indiana:			
Frankfort, Lockwood Lake			2,000
Michigan City, Kilnitz Creek			5,000
North Liberty, Schrader's pond			5,000

DISTRIBUTION OF FISH AND FISH EGGS, BY LOCALITY AND SPECIES, FISCAL YEAR 1913—Continued.

BROOK TROUT—Continued.

Disposition.	Eggs.	Fry.	Fingerlings, yearlings, and adults.
Iowa:			
Arlington, Deep Creek			1,000
Phillips Creek			800
McGregor, Bloody Run			400
Manchester, Spring Branch			10,000
Nora Springs, Spring Lake			600
North McGregor, Bloody Run			800
Postville, Swingood Spring Branch			400
Strawberry Point, Cass Lake			1,000
Waukon, Sherman Creek			800
Kentucky:			
Morehead, Garten Lake			4,000
Olive Hill, Denues Pond			500
Shelby, Goodwater Lake			300
Maine:			
Bangor, Crosby Pond		20,000	
Mass Bog Pond		10,000	
Upper Hathorn Bog		10,000	
Biddeford, Batson River		15,000	
Boiling Spring Brook		5,000	
Cascade Brook		15,000	500
Cold Spring Brook		35,000	
Deep Brook		15,000	
Dyer Brook		10,000	500
Goose Fair Brook		15,000	
Hill Brook		10,000	500
Kimball Brook			500
Little Milliken Brook		5,000	500
Lord Brook		15,000	
Murch Brook		5,000	
Ricker Brook		10,000	
Sandy Brook		10,000	500
Silley Brook		10,000	
Tapley Brook		5,000	
Towle Brook		5,000	
Whitehouse Brook		5,000	
Bigelow, Cranberry Peak Pond		20,000	
Mount Bigelow Pond		20,000	1,800
Stratton Brook		20,000	
Stratton Brook Pond		20,000	
Bingham, East Carry Pond		30,000	
Rowe Pond			2,000
Boothbay Harbor, Adam's pond		15,000	
Campbell's pond		15,000	
Bridgton Junction, Crystal Lake		40,000	
Long Lake		25,000	
Bucksport, Patten Pond			4,000
Toddy Pond			2,500
Cumberland Center, Piscataqua River			1,500
Dedham, Green Lake		100,000	
Phillips Lake		50,000	
Dead River Station, Nash Stream		15,000	
Dennysville, Dennys River			2,000
East Orland, Craig Pond			872
Heart Pond			2,425
Toddy Pond			4,330
Ellsworth, Quarry Pond		5,000	
Farmington, Beaver Pond		20,000	
Big Island Pond		20,000	
Big Northwest Pond		20,000	
Indian Creek		10,000	
Little Island Pond		50,000	
Long Pond		20,000	
Lower Pond		20,000	
Meadow Grounds Pond		20,000	
Natanias Pond		20,000	
Rock Pond		20,000	
Round Pond		20,000	
Secret Pond		10,000	
Seven Ponds Creek		30,000	
Franklin, Spring River Lake		35,000	
Grand Lake Stream, Grand Lake Stream		1,688	
Green Lake, Mann's brook			10,403
Greenville Junction, Arnold Pond		20,000	
Horseshoe Pond		20,000	

DISTRIBUTION OF FISH AND FISH EGGS, BY LOCALITY AND SPECIES, FISCAL YEAR 1913—Continued.

BROOK TROUT—Continued.

Disposition.	Eggs.	Fry.	Fingerlings, yearlings, and adults.
Maine—Continued.			
Holeb, McKinney Brook			500
Island Falls, Mattawamkeag Lake		50,000	
Jackman, Attean Lake			1,000
Bass Lake			500
Bengman Pond			500
Berry Pond			500
Bickford Pond		40,000	
Bog Brook		15,000	500
Cold Stream Pond			500
Deer Pond		15,000	500
Grace Pond		20,000	
Hale Pond			500
Hatchery Brook			1,000
Heald Pond			500
Horatio Pond			500
Indian Pond		15,000	
Jones Pond			500
Lake Parlin			500
Lake Wood		20,000	1,000
Long Pond			500
Lowell Pond		15,000	
Mac Pond			500
Moose Pond			500
Mud Pond		40,000	
Newton Pond			460
Rancourt Pond			500
Sugar Berth Pond			500
Toby Ponds		30,000	
Williams Brook			1,000
Kennebunk, Kennebunk River tributaries			500
Machias, Cathance Lake			2,000
Madison, Hayden Lake			4,800
Manset, Stanley Pond			2,000
Mapleton, Alder Brook		15,000	
Monmouth, Purgatory Pond			4,500
Sand Pond			4,000
Mosquito, State fish commission	100,000		
North Ellsworth, Branch Pond		50,000	
Orland, Craig Pond			1,500
Presque Isle, Pennington Brook		10,000	
Presque Isle Creek			1,500
White's brook			1,000
Rangeley, Haley Pond			2,000
Schoodic, Schoodic Lake		40,000	
Searsport, Swan Lake		20,000	
Strong, Cranberry Peak Pond		10,000	
Tunk Pond, Tunk Pond		50,000	
Waldoboro, Medomak River		20,000	
Walker, Squawpan Lake		50,000	
Waterville, Missalauskee Lake		26,667	
West Ellsworth, Pattens Pond		75,000	
West Kennebunk, Swan Pond		15,000	
West Paris, Abbott Pond			2,000
Concord River			1,000
Shagg Pond			2,000
Twenty-Mile River			2,000
Maryland:			
Altamont, Little Youghiogheny River			3,000
Clearspring, Big Springs Run			800
Frostburg, Savage River			9,500
Gunpowder, Gunpowder River			800
Hagerstown, Lisheigs Run			200
Hampstead, Murphy's run			490
Kitzmiller, Laurel Run			10,000
Lost-Land Run, North and South Branches			600
Wolf Den Run			400
Lonaconing, Poplar Lick Creek			5,700
Little Savage River			7,600
Mud Lick Run			4,700
Monkton, Holme's branch			400
Little Gunpowder and tributaries			2,800
Mountain Lake Park, Block Run			5,000
Broadford Run			5,350
Comegys Run			600
Little Youghiogheny River			600
Lost-Land Run			4,750
Trout Run			4,750

DISTRIBUTION OF FISH AND FISH EGGS, BY LOCALITY AND SPECIES, FISCAL YEAR 1913—Continued.

BROOK TROUT—Continued.

Disposition.	Eggs.	Fry.	Fingerlings, yearlings, and adults.
Maryland—Continued.			
Oakland, Arnold Run			3,800
Big Run			3,800
Dunkard Lick Run			3,800
Edgewood Lake			2,850
Grove Run			4,000
Millers Run			3,800
Muddy Creek			9,500
North Cherry Creek			4,750
Round Glade Run			3,800
Spring Pond			2,000
Thurmont, Hunting Creek			10,000
Massachusetts:			
Athol, Swift River, East Branch			500
Baldwinville, Norcross Pond			1,000
Conway, Lowells Pond			300
Dedham, Weld's ponds		5,000	
Gardner, Bennet Brook			1,000
Brigham Brook			1,000
Cook Brook			1,000
Cunnistowe Brook			1,000
Hale Brook			1,000
Mare Meadow Brook			1,000
Tanyard Brook			1,000
Whitcomb Brook			1,000
Greenfield, Stone Brook			300
Holyoke, Stony Brook			300
Lancaster, Peterson's pond			1,500
Monson, Conant Brook		15,000	
New Salem, Tire Brook			1,000
North Falmouth, Ashumet Pond		20,000	
Otter River, Bailey Brook			300
Bigelow Brook			300
Brigham Brook			300
Perley Brook			300
Underwood Pond			300
Vining Brook			300
Rockland, Silver Brook			3,000
Washington, Westfield River		15,000	
Westfield, Little River		25,000	
Michigan:			
Alpena, Comstock Creek			1,500
Muskrat Creek			1,500
Norwegian Creek		2,700	
Wildcat Creek			4,000
Baldwin, Pere Marquette River			10,000
Bellaire, Shanty Creek		5,000	
Bitely, Cedar Creek		5,000	
Black River, Black River			15,000
Boyne Falls, Boyne River		10,000	
Branch, Weldon Creek		5,000	
Carp Lake, Carp River		2,500	7,500
Central Lake, Central Lake		5,000	
Clare, Clear Creek		5,000	
Five Lake Creek		5,000	
Halstead Creek		5,000	
Henderson Creek		5,000	
Lowery Creek		5,000	
McEwan Creek		5,000	
McKinley Creek		5,000	
Mater Creek		5,000	
Moose Creek		5,000	
Number Four Creek		5,000	
Pump House Creek		5,000	
Tobacco River		5,000	
Tobacco River, South Branch		10,000	
Crystal Falls, Paint River			900
Dryden, Belle River		5,000	
East Tawas, Pickett Creek			50,000
Emery Junction, Hale Creek			20,000
Farwell, Littlefield Creek		10,000	
Grayling, Au Sable River, North Branch		11,000	
Black River		13,000	
Pigeon River		11,000	
Sturgeon River		11,000	
Harrietta, McKinley Creek		3,000	
Slagle River			10,000

DISTRIBUTION OF FISH AND FISH EGGS, BY LOCALITY AND SPECIES, FISCAL YEAR 1913—Continued.

BROOK TROUT—Continued.

Disposition.	Eggs.	Fry.	Fingerlings, yearlings, and adults.
Michigan—Continued.			
Hillman, Cold Creek		10,000	
Deer Creek			2,000
Webber Creek		12,000	
Indian River, Little Pigeon River		19,500	
Pigeon River		27,500	
Interlochen, Platte River		10,000	
Isle Royale, Big Siskiwit Creek			4,000
Little Siskiwit Creek			4,000
Washington Club Creek			4,000
Kaleva, Cedar Creek		10,000	
Leetsville, Rapid River		10,000	
Lewiston, Gilchrist Creek			15,000
Hunt Creek			12,000
Little Manistee, Little Manistee River		20,000	
Marcellus, Brandy Brook		7,500	
School Creek		7,500	
Millersburg, Indian River		5,000	
Little Ocqueoc River		10,000	
Ocqueoc River		20,000	
Rainy River, North Fork		5,000	
Newayo, Bigelow Creek		15,000	
Penanger Creek		5,000	
Niles, Campbell's ponds			2,000
Lake Chapin		20,000	
Nirvana, Sanburn Creek		15,000	
Ossineke, Devil River			15,000
Peacock, Sable River		10,000	
Pellston, Maple River		10,000	
Provemont, Peters Creek			2,000
Riverview, Black Creek			2,500
Cold Creek			1,000
Ox Bo Creek			2,000
Rocky Creek			4,000
Rose Center, Spring Brook		5,000	
Willow Creek		5,000	
Thompsonville, Betsey River			10,000
Little Betsey River		10,000	
Traverse City, Boardman River			5,500
Tustin, Pine River		10,000	
Walton Junction, Manistee River		10,000	
White Cloud, White River		20,000	15,000
Wingleton, Sweetwater Creek		15,000	
Minnesota:			
Caledonia, Badger Creek			5,000
Beaver Creek			5,000
Crooked Creek			5,000
Crystal Valley Creek			5,000
Dexter Creek			5,000
Eastcott Creek			5,000
Irish Creek			5,000
Thompson Creek			5,000
South Fork Creek			5,000
Winnebago Creek			5,000
Carlton, Blackhoof Creek			7,000
Otter Creek			7,000
Duluth, Woodland Brook			5,000
Harmony, Tostenson Creek			800
Knife River, Baptism River			24,000
Beaver River			4,000
Crystal Brook			4,000
Gooseberry River			4,000
Knife River			4,000
Split Rock River			4,000
Temperance River			4,000
Tettegouche River			8,000
Lamoille, Big Trout Creek			2,000
Cedar Valley Creek			3,000
Little Trout Creek			3,000
Pickwick Creek			2,000
Pine Creek			3,000
Richmond Creek			3,000
Rutherford Creek			3,000
Lanesboro, Diamond Creek			800
Gribbins Creek			400
Onstim Creek			400

DISTRIBUTION OF FISH AND FISH EGGS, BY LOCALITY AND SPECIES, FISCAL YEAR 1913—Continued.

BROOK TROUT—Continued.

Disposition.	Eggs.	Fry.	Fingerlings, yearlings, and adults.
Minnesota—Continued.			
Lanesboro, Sletvold Creek			400
Torgerson Creek			400
Lewiston, Enterprise Creek			2,000
Ferguson Creek			2,000
Rush Creek			3,000
Stockton Valley Creek			2,000
White Water River, South Branch			3,000
Minnesota City, Bear Valley Creek			2,000
Rollingstone Creek			3,000
Ruppecht Valley Creek			2,000
Speltz Valley Creek			3,000
Straight Valley Creek			2,000
Plainview, Beaver Creek			2,000
Logan Creek			2,000
Middle Creek			2,000
East Indian Creek			3,000
West Indian Creek			2,000
White Water River			3,000
White Water River, North Branch			2,000
Preston, Big Spring Creek			5,000
Camp Creek			400
Douschell Creek			5,000
North Branch Creek			400
South Branch Creek			800
Sugar Creek			5,000
Trout Run			5,800
Watson Creek			800
Willow Creek			5,400
Wisel Creek			800
Red Wing, Hay Creek			6,400
Wells Creek			600
Rushford, Coledge Creek			400
Diamond Creek			400
Enterprise Creek			400
Ferguson Creek			400
Hemingway Creek			400
Mead Creek			400
Overland Creek			400
St. Charles, Campbells Branch			3,000
Carters Run			2,000
Crows Creek			2,000
Demuths Creek			2,000
Hemingway Creek			2,000
Holmes Spring Creek			2,000
Holts Spring Creek			2,000
Logan Branch			2,000
Loys Spring Creek			2,000
Nichols Creek			3,000
Omaree Creek			3,000
Pettis Creek			2,000
Pfuls Spring Creek			2,000
Pine Creek			3,000
Quincy Creek			2,000
Rush Creek			3,000
Trout Run			2,000
Troy Creek			2,000
Whitewater River			3,000
Whitewater River, Middle Branch			3,000
Whitewater River, North Branch			3,000
Whitewater River, South Branch			3,000
Winona, Bear Valley Creek			3,000
Corey Valley Creek			2,000
Dearing Valley Creek			2,000
East Burns Valley Creek			2,000
Gilmore Valley Creek			2,000
Ginthen Valley Creek			3,000
Middle Valley Creek			2,000
Millers Creek			2,000
Morey Creek			3,000
Pleasant Valley Creek			3,000
Rupprecht Valley Creek			3,000
Speltz Valley Creek			3,000
Stockton Valley Creek			3,000
Straight Valley Creek			3,000
West Burns Valley Creek			2,000
Wiscoy Creek			3,000

DISTRIBUTION OF FISH AND FISH EGGS, BY LOCALITY AND SPECIES, FISCAL YEAR 1913—Continued.

BROOK TROUT—Continued.

Disposition.	Eggs.	Fry.	Fingerlings, yearlings, and adults.
Missouri:			
St. Louis, applicant	500		
Montana:			
Armstead, Horse Prairie Creek			450
Warm Spring Brook			150
Belt, Belt Creek			750
Highwood Creek			750
Belton, McDonald Creek			750
Big Timber, Deer Creek			4,000
Bozeman, Asbestos Creek			2,000
Beaver Creek			1,000
Bostwick Creek			3,000
Bridger Creek			10,485
Buck Creek			1,000
Buffalo Horn Creek			2,000
Cache Creek			1,000
Chapman Pond			400
Cherry Creek, tributaries			4,000
Cottonwood Creek			2,000
Cottonwood Creek, North Fork			5,000
Dailey Creek			2,000
Greek Creek			2,000
Hell Roaring Creek			3,500
Johnson Creek			1,000
Lansing Creek			4,000
Logger Creek			6,000
Lost Creek			1,000
Meadow Creek			2,500
Moose Creek			3,000
Olson Creek			2,000
Pasha Creek			500
Porcupine Creek			2,000
Rainbow Lake			10,000
Rocky Creek			4,000
Sago Creek			5,000
Sales Creek			4,000
Spanish Creek, tributaries			25,000
Spanish Creek, Middle Fork			4,000
Spanish Creek, North Fork			4,000
Spanish Creek, South Fork			4,000
Specimen Creek			2,000
Squaw Creek			1,500
Swan Creek			1,500
Taylor Creek			2,000
Taylors Fork Creek			1,500
Trail Creek			7,200
Twin Lake			5,000
West Fork Creek			2,000
Wilson Creek			2,000
Corwin, Bissett Creek			2,500
Dillon, Selway Creek			300
Divide, Jimmie New Run			150
Drummond, Shoop Lake			400
Edgar, Tryor Creek			280
Gardiner, Glenn Creek			26,000
Geyser, Arrow Creek			750
Cottonwood Creek			750
Davis Creek			750
Martin Creek			500
Hamilton, Skalkaho Creek			400
Jefferson City, Prickley Pear Pond			1,600
Kalispell, Small's Spring Creek			500
Spring Creek			500
State fish commission	200,000		
Lennep, Little Cottonwood Creek			600
Lewistown, Armells Creek, East Fork			750
Armells Creek, Middle Fork			300
Spring Creek			300
Livingston, Bauman's pond			1,000
Deep Creek			5,000
Fleshman Creek			8,000
Mission Creek			10,000
Pine Creek			5,000
Suce Creek			5,000
Trail Creek			5,000
Lombard, Sixteen Mile Creek			2,500

DISTRIBUTION OF FISH AND FISH EGGS, BY LOCALITY AND SPECIES, FISCAL YEAR 1913—Continued.

BROOK TROUT—Continued.

Disposition.	Eggs.	Fry.	Fingerlings, yearlings, and adults.
Montana—Continued.			
Manhattan, Baker Creek			10,000
Camp Creek			10,000
Bulls Run			5,000
North Fork Creek			1,000
Spring Creek			10,000
Martinsdale, Cottonwood Creek			4,800
Melrose, Canyon Creek Lake			450
Moore, Dockens Creek			750
Judith River			7,200
Rock Creek			750
Neihart, Sawmill Creek			500
Philipsburg, Adams Lake			200
Red Lodge, Rock Creek Lakes			2,500
Rimini, Ten Mile Creek and tributaries			1,000
Salesville, Cherry Creek			6,000
Sheridan, Indian Creek			600
Mill Creek			600
Wisconsin Creek			600
Stevensville, Mill Creek Lake			400
Sumatra, Herbold's pond			1,000
Three Forks, Orsten's pond			450
Townsend, Crow Creek			15,000
Deep Creek			15,000
Greyson Creek			10,000
Twodot, Agnes Creek			600
Wilsall, Horse Creek			7,500
Winston, Antelope Creek			1,200
Yakt, Pine Creek			280
Nevada:			
Verdi, State fish commission	50,000		
New Hampshire:			
Berlin, Chandler Brook			4,000
Charlestown, Benware Brook		15,000	
Reservoir Brook		15,000	2,000
Claremont, Copeland Brook			2,000
Concord, Cunningham's pond			100
Great Brook			300
Kimball Brook			200
One Stock Brook			300
Trout Brook			200
Stevens Brook			300
White Rock Brook			200
Whittemore Brook			200
Epsom, Porter Bickford Brook			2,000
Fabyans, Ammonoosuc River		10,000	
Anderson Lake		3,000	
Bear Brook		3,000	
Black Brook		8,000	
Bretton Woods Lake		5,000	
Clay Brook		3,000	
Clinton Brook		5,000	
Crawford Brook		5,000	
Deception Brook		3,000	
Jefferson Brook		5,000	
Grafton, Wildmeadow Brook and Pond			500
Greenfield, Farrington Brook		10,000	
Gulf Brook		5,000	
Hartshorn Brook		5,000	
Smith Brook		10,000	
South Brook			2,000
Lee, Knowlton's pond			1,000
Newbury, Lake Sunapee		49,900	
Peterborough, Town Line Brook			2,000
Potter Place, Lake Pleasant			10,000
Sanbornville, Mountain Lake			500
Warner, Asquel Brook			1,500
French Brook			2,000
Meadow Brook No. 1			2,000
Meadow Brook No. 2			1,500
Smith Brook		5,000	
Stevens Brook			2,000
Webb, Perry Brook			300
West Swanzey, Bolles Brook			300
Branch Brook			500
Perry Brook			500
Winchester, Mira Brook			700

DISTRIBUTION OF FISH AND FISH EGGS, BY LOCALITY AND SPECIES, FISCAL YEAR 1913—Continued.

BROOK TROUT—Continued.

Disposition.	Eggs.	Fry.	Fingerlings, yearlings, and adults.
New Jersey:			
Bloomsbury, Braun's pond			500
Paterson, Stalters Brook			1,000
Stalter's pond			1,000
Princeton, applicant	3,500		
New Mexico:			
Dexter, Lake Van			1,600
Glorieta, Mora River			8,000
Pecos River			16,000
Hagerman, Hagerman Reservoir			800
Las Vegas, Gallinas River			10,000
Magdalena, South Diamond Creek			3,000
Raton, Rayole River			16,000
Ribera, Pecos River			10,000
Rowe, Pecos River			20,000
Taiban, Taiban River			800
Ute Park, Rio Grande			15,000
New York:			
Apulia, Butternut Creek		25,000	
French Brook		5,000	
Markham Hollow Brook		10,000	
Mills Brook		10,000	
Ranger Brook		10,000	
Battery Park, New York Aquarium	5,000		
Beaver River, Beaver River			500
Benson Mines, Little River		15,000	
Twin Lakes			500
Big Indian, Esopus Creek			1,000
Boiceville, Travers Hollow Brook			200
Brewster, Croton River, Middle Branch			1,500
Cairo, Bunker Hill Creek		5,000	
Cambridge, Devils Hollow Brook		5,000	
Dunraven, Delaware River, East Branch			1,500
Ellenville, Rondout Creek, East Branch			200
Vernooy Kill Creek			300
Elmira, Hoffman's pond			500
Erieville, Hamilton Brook			1,000
Morrow Brook			500
Perry Smith Brook			500
Wagoner Brook			1,000
Forestport, Little Woodhull Creek			600
Fulton Chain, Bisby Lake		30,000	
Little Moose Lake		30,000	
Georgetown, Morris Brook			1,000
Otselic Brook			1,000
Great Bend, Black Creek		20,000	
Halfway, De Montfredie Brook		15,000	
Harrisville, South Creek Lake		15,000	
Ligas Lake		15,000	
Homer, Crouse's pond		15,000	300
Kerhonkson, Mill Brook			300
Lake Placid, Ausable River		10,000	
Chub River		10,000	
Lake Placid		30,000	
Lisle, Dudley Creek			300
Long Eddy, Basket Brook			1,000
Margaretville, Delaware River, East Branch			1,500
Morrisonville, Riley Pond			500
State Road Brook			1,000
Newark, Military Brook		5,000	
New City, Thornfield Brook			500
New Lebanon, Burnemead Brook			1,000
Cold Spring Brook			1,000
Dean Brook			1,000
Shaker Brook			1,000
West Meadow Brook			1,000
Wyomonock Creek			2,000
Northville, Charley Lake			1,500
Hayes Lake			1,500
Oneonta, Baker Brook		5,000	
Butternut Creek		20,000	
Charlotte Creek		35,000	
Hackley's creek		5,000	
Keyes Brook		5,000	
Meridale Pond		10,000	
Otego Creek		20,000	
Otego Creek, tributary		15,000	

DISTRIBUTION OF FISH AND FISH EGGS, BY LOCALITY AND SPECIES, FISCAL YEAR 1913—Continued.

BROOK TROUT—Continued.

Disposition.	Eggs.	Fry.	Fingerlings, yearlings, and adults.
New York—Continued.			
Oneonta, Pool Brook		6,000	
Powell Creek		5,000	
Robinson Creek		5,000	
Owego, Talcott Brook		5,000	
Catalonk Creek		15,000	
Doolittle Creek		5,000	
East Creek		10,000	
Owego Creek		5,000	
West Creek		15,000	
Patterson, Croton River			1,500
Quaker Brook			1,000
Piercefield, Catamount Lake			1,600
Port Henry, Club House Brook and Pond		15,000	
Ledge Pond		10,000	
Little Club House Pond		5,000	
Lower Moss Pond		10,000	
Upper Club House Brook		5,000	
Upper Moss Pond		10,000	
Schroon River		10,000	
Port Jervis, Bemis Brook			400
Richland, Hilton Brook			100
Orwell Brook			200
Pekin Brook			200
Potter Brook			200
Richmondville, Panther Creek		8,000	
Rome, Direnn Creek		20,000	
Fish Creek		20,000	
Pringle Brook		20,000	
Roaring Brook		10,000	
Schenevus, Elk Creek		20,000	
Shokan, Maltby Hollow Creek			200
Shushan, Battenkill River		15,000	
Camden Brook		25,000	
Sidney, Hyatt Brook			200
Masonville Brook			200
Peckham Brook			200
Rogers Hollow Brook			200
South Berlin, Fuller Brook			1,000
Hemlock Branch			1,000
Kronk Brook			1,000
Springville, Smith Brook		6,000	
St. Regis Falls, St. Regis River		24,000	
Syracuse, Bear Trap Creek			300
Carpenter Brook		35,000	
Elmwood Brook			300
Geddes Brook			300
Pebble Hill Pond		5,000	
Swamp Brook			300
Unadilla, Cans Creek		20,000	
Ouleout Creek		20,000	
Rogers Hollow Creek		20,000	
Utica, Jones's pond		5,000	
Wallace, Wessels Creek			300
Warwick, Double Kill Run			3,500
Watertown, Deer Lick Creek		10,000	
Felts Mills Creek		20,000	
French Creek		10,000	
Johnsons Creek		10,000	
Kings Creek		10,000	
Martin Creek		10,000	
Tolley Pond		10,000	
Willsboro, Higby Brook			300
Sky Pond			300
Warm Pond			300
North Carolina:			
Andrews, East Buffalo Creek			225
Santeetlah Creek			225
Apalachia, Bear Creek			3,000
Bethania, Hunter's pond			75
Biltmore, Cane Creek, Rocky Fork			2,150
Brevard, Brushy Creek			2,000
Buckhorn Creek			150
Cannon Creek			2,000
Carson Creek			2,000
Cedar Rock Creek			1,200
Grogan Creek			150

DISTRIBUTION OF FISH AND FISH EGGS, BY LOCALITY AND SPECIES, FISCAL YEAR 1913—Continued.

BROOK TROUT—Continued.

Disposition.	Eggs.	Fry.	Fingerlings, yearlings, and adults.
North Carolina—Continued.			
Prevard, Grohe's creek			2,000
Nicholson's creek			2,000
Rocky Creek			2,000
Williamson's Creek			800
Cherryfield, Cherryfield Creek			2,000
Mount Walter Creek			500
Oliver's creek			1,000
Paxton Creek			1,750
Weams Creek			2,000
Elk Park, Belch Creek			4,000
Boons Fork Creek			5,000
Elk Creek, South Fork			500
Little Elk Creek			1,200
North Toe River			500
High Point, Spring Branch			150
Horse Shoe, Queens Creek			150
Lake Toxaway, French Broad River, West Fork			500
Linville Falls, Catawba River, North Fork			300
Minneapolis, Fall Branch			2,000
Montezuma, Grandmother Creek			3,000
Kawana Lake			2,000
Kentucky Creek			2,000
Linville River			4,000
Linville River, West Fork			2,000
Toe River, East Fork			1,200
Murphy, Dinkins Creek			75
Palmer Creek			75
Old Fort, Bird Creek, West Fork			1,200
Jaret's creek			1,000
Penrose, Cherrytree Creek			1,200
Gash's creek			150
Glady Creek			150
Lydays Creek			150
Patty Creek			1,600
Shoal Creek			2,000
Tom's creek			500
Turkey Creek			2,000
Pisgah Forest, Black Snake Creek			250
Lambs Creek			150
Silver Creek			2,400
Suttons Creek			2,000
Turkey Creek			150
Wilsons Creek			2,000
Rutherfordton, Kettle House Branch			1,000
Saluda, Cove Creek			300
Gads Creek			150
Gilbert Creek			300
Selica, Mill Creek			1,000
Sylva, White Rock Creek			2,000
Wolf Creek			2,000
Tryon, Pocolet River, tributary			825
Tuxedo, Cherry Creek			2,000
Freemans Creek			150
Green River, branch			150
Rock Creek			3,000
Violet, Elbow Creek			3,000
Shoals Creek			3,000
Slate Creek			4,000
Waynesville, West Fork Pigeon River			225
North Dakota:			
Mott, Cannon Ball River			8,000
New Salem, Silver Spring Pond			600
Springbrook Pond			400
Ohio:			
Bellefontaine, Mad River		10,000	
Stony Creek		5,000	
Stony Creek, tributary		5,000	
Garrettsville, Stewart Creek			5,000
Kinsman, Bidwell Creek			5,000
Mansfield, Bently Lake		2,000	
Pleasant Valley Run		12,000	
Portsmouth, Turkey Creek			10,000
Oklahoma:			
Enid, Spring Lake			300

DISTRIBUTION OF FISH AND FISH EGGS, BY LOCALITY AND SPECIES, FISCAL YEAR 1913—Continued.

BROOK TROUT—Continued.

Disposition.	Eggs.	Fry.	Fingerlings, yearlings, and adults.
Oregon:			
Bonneville, State fish commission	300,000		
Carlton, North Yamhill River		1,000	
Duncan, Meacham Creek		2,000	
Forest Grove, Unscheid's pond		1,000	
Gibbon, Umatilla River		4,000	
Hood River, Hood River		2,000	
Lakeview, Rock Creek			1,000
McMinnville, Baker Creek		2,000	
Oregon City, Trout Creek		4,000	
Pendleton, Bear Creek		2,000	
Birch Creek, East Fork		2,000	
McKay Creek		2,000	
Pilot Rock, Big Creek		4,000	
Bridge Creek		1,000	
Butter Creek, East Fork		4,600	
Cable Creek		1,000	
Camas Creek		4,000	
Desolation Creek		4,000	
Five Mile Creek		1,000	
Hidiway Creek		4,000	
Owens Creek		4,000	
Snipe Creek		1,000	
Winam Creek		3,000	
Sheridan, Bible Creek		2,000	
Willamina, Willamina River		2,000	
Pennsylvania:			
Allentown, Trout Creek			210
Austin, Bark Shanty Run			1,000
Berg Run			1,000
Big Moores Run			1,500
Birch Run			1,000
Cowley Run			1,500
East Deering Run			1,000
Freeman Run			1,000
Little Moores Run			1,000
Little Nelson Run			1,000
Nelson Run			1,000
Prouty Run			1,000
Sinnamahoning River			1,000
South Woods Run			1,500
West Branch Run			1,000
Bainbridge, Lindimuth Run			800
Bath, Edgewood Pond			500
Beartown, Lincoln's run			420
Shirk's run			400
Benton, Brink River			300
Bully Run			100
Fishing Creek			300
Keefer Run			100
Kile's brook			100
Long Run			100
Raven Creek			200
Savage Run			300
Spring Run			100
Bethlehem, Monocacy Creek			1,000
Bingham, Railroad Run			225
Wolf Run			225
Boiling Springs, Boiling Springs Lake			275
Bradford, Buck Lick Creek			75
Chapple Fork Creek			875
Fuller Brook			75
Gilbert Run			75
Lynn Valley Creek			75
North Branch			75
Oil Valley Creek			75
Quaker Run			875
Sugar Run			950
Tuna Creek, East Branch			875
Tuna Creek, West Branch			875
Willow Creek			875
Wintergreen Run			875
Wolf Run			600
Brandamore, Long's run			800
Brockwayville, Whetstone Run			1,000
Brookland, Little Cushing Creek			2,000
Bushkill, Beaver Dam Brook			5,000

DISTRIBUTION OF FISH AND FISH EGGS, BY LOCALITY AND SPECIES, FISCAL YEAR 1913—Continued.

BROOK TROUT—Continued.

Disposition.	Eggs.	Fry.	Fingerlings, yearlings, and adults.
Pennsylvania—Continued.			
Cammal, Trout Run			1,500
Carlisle, Letort Spring Run			1,000
Catawissa, Roaring Creek			1,000
Central, Hog Run			200
Painter Run			200
Cherry Tree, Shryhock Run			800
Silver Run			800
Clarendon, Big Arnot Creek			225
Farnsworth Creek			225
Four Mile Run			225
Little Arnot Creek			225
Tionesta Creek			225
Wildcat Creek			75
Clearfield, Big Three Run			165
Fork Run			165
Lick Run			110
Little Three Run			110
Stone Run			165
Trout Run			110
Cly, Hay Run			800
Coles Creek, Coles Creek, tributary of			400
Coudersport, Allegheny River			800
Allegheny Creek			400
Baker Creek			800
Bark Mill Branch			400
Bark Shanty Run			400
Bly Branch			400
Brown Hollow Run			400
Chappel Branch			400
Clark Run			400
Colcord Branch			400
Colesburg Creek			400
Creamery Run			400
Dingee Branch			400
Dingman Run			400
Earl Run			400
East Cowley Run			400
Elm Flat Run			400
Ellison Branch			400
Ensign Run			400
First Fork Run			400
Foumes Branch			400
Fox Run			400
Freeman Run			400
Frink Run			400
Gale Run			400
Glover Branch			400
Hendrix Run			400
Hoxie Run			400
Inez Run			400
Left Rees Creek			400
Lewis Branch			400
Lookout Branch			400
Metzgar Branch			400
Mill Creek			400
Mitchell Branch			400
Neff Branch			400
Nelson Creek			800
North Branch Run			400
North Hollow Run			400
Oswayo Creek			400
Phelps Spring Run			400
Pine Run			400
Prosser Hollow Run			400
Quimby Branch			400
Raymond Branch			400
Rees Hollow Run			400
Ross Run			400
Seven Bridges Run			400
Sinnemahoning Creek			400
Smith Run			400
South Woods Branch			400
State Road Run			800
Stephens Run			800
Steer Brook			400
Sweden Run			400

DISTRIBUTION OF FISH AND FISH EGGS, BY LOCALITY AND SPECIES, FISCAL YEAR 1913—Continued.

BROOK TROUT—Continued.

Disposition.	Eggs.	Fry.	Fingerlings, yearlings, and adults.
Pennsylvania—Continued.			
Coudersport, Swing Run			400
Taggart Run			400
Thompson Branch			400
Tolls Run			400
Turnpike Run			400
Walker Run			400
Wambold Run			400
West Cowlee Creek			400
Whitney Creek			400
Windfall Run			400
Cresco, Bushkill River			3,000
Cressona, Bartlesback Creek			200
Deitus Creek			200
Panther Creek			200
Curwensville, Andersons Creek			1,000
Bear Run			500
Bilgers Run			500
Blooms Run			500
Hartshorn Run			500
Montgomery Run			1,500
Norris Run			500
Roaring Run			500
Twin Run			500
Delta, Keyser's pond			210
Downingtown, Broad Run and tributaries			1,000
Pine Run			210
Driftwood, Gore Draft Run			500
Hick Run			1,000
Laurel Run			1,000
Miller Run			1,000
Mix Run			1,000
Mix Run, Little Fork			500
Page Run			1,000
Red Run			1,000
Sander Draft Run			500
White Oak Run			500
Wykoff Run			1,000
Easton, Bushkill Creek			840
Fern Glen, Crooked Run No. 1			200
Crooked Run No. 2			200
Roberts Run			200
Florin, Big Spring Run			540
Galeton, Back of Lot Brook			1,000
Beech Creek			75
Buckseller Run			1,075
California Creek			1,075
Commission Run			1,000
Cushing Creek			1,075
Daggett River			1,000
Gale Run			1,000
Hopperhouse Hollow Run			1,000
Indian Run			75
Jacobs River			75
Joes Creek			75
Johnson Brook			75
Judson Run			1,000
Kettle Creek			75
Lahyman Branch			1,000
Little Kettle Creek			75
Lossey Run			1,075
Meeker Run			75
Nine Mile Run			75
Painter Run			1,000
Phoenix Creek			75
Pine Creek			950
Pine Creek, South Branch			1,000
Slider Branch			75
Sunken Branch			1,075
Toms Cabin Run			1,000
Wetmore Run			1,000
Gap, Cattail Run			1,200
Ellmaker Run			800
Livingstons Hollow Run			1,200
Umbletown Run			1,200
Glasgow, Curtic Run			240
Hallton, Big Run			220

DISTRIBUTION OF FISH AND FISH EGGS, BY LOCALITY AND SPECIES, FISCAL YEAR 1913—Continued.

BROOK TROUT—Continued.

Disposition.	Eggs.	Fry.	Fingerlings, yearlings, and adults.
Pennsylvania—Continued.			
Hecla, Cold Run			500
Hoadleys, Middle Creek			400
Spring Creek			200
Wangum Creek			300
Hughesville, Shingle Run			200
Hull, East Fork Creek			75
Proudy Creek			75
Hydetown, Wheeler Run			150
Indian Creek, Mill Run			400
Nicolay Run			200
Jamison City, Rough Run			200
Jersey Shore, Chatams Run			300
Frusworth Run			300
Johnstown, Alwin Run			400
Baker Run			600
Beaver Run			500
Beaver Dam Run			500
Bens Creek			600
Bens Creek, North Fork			100
Bens Creek, South Fork			100
Big Spring Run			300
Blue Hole Run			300
Breastwork Run			900
Calendar Run			800
Canfield Run			100
Caples Run			200
Card Machine Run			200
Clear Run			200
Clear Shade Run			300
Conemaugh River, South Fork			800
Cub Run			300
Daily Draft Run			200
Dalton Run			600
Dark Shade Run			300
Deeters Creek			200
Gray Run			100
Henaaries Creek			800
Hincksons Run			100
Imgrunt Run			200
Johns Mill Run			200
Jones Mill Run			300
Kimberlens Run			200
Laurel Run			200
Laurel Run No. 1			100
Laurel Run No. 2			100
Laurel Hill Run			200
Lick Run			200
Little Mill Creek			100
Little Shade Run			300
Mill Creek			300
Miller Run			600
Millstone Run			200
Mishler Run			100
Picking Run			200
Piney Run			200
Piney Run No. 1			100
Piney Run No. 2			100
Pletcher Run			300
Powder Mill Run			500
Red Run			300
Rhodes Creek			200
Risinger Run			100
Roaring Run			200
Salt Lick Run			500
Sandy Run			300
Shannon Run			700
Shingle Run			500
Solomons Run			200
Stuart Run			200
Sugar Run			300
Three Spring Run			200
Tub Mill Run			600
Wildcat Run			300
Kellettville, Fork Run			150
Four Mile Run			150
Little Salmon Branch			150

DISTRIBUTION OF FISH AND FISH EGGS, BY LOCALITY AND SPECIES, FISCAL YEAR 1913—Continued.

BROOK TROUT—Continued.

Disposition.	Eggs.	Fry.	Fingerlings, yearlings, and adults.
Pennsylvania—Continued.			
Kellettville, Salmon Creek			150
Six Mile Run			150
Kingston, Pikes Creek			500
Kinzers, Londonland Run			1,000
Meadowbrook Run			1,200
Lancaster, Blue Ball Run			1,600
Cattail Run			1,600
Gest's run			1,200
Gontners Run			1,600
Herr's run			1,200
Kelly Creek			1,100
Landis Run			1,200
Stehmans Run			1,600
Trout River			2,000
Welks Run			1,600
Lanesboro, Brushville Creek			1,000
Canawacta Creek			500
Cascade Creek			1,000
Dodge Brook			500
Egypt Creek, East Branch			500
Egypt Creek, West Branch			1,000
Hemlock Creek, East Branch			1,000
Hemlock Creek, West Branch			1,000
Roaring Brook			500
Wildcat Creek			500
Latrobe, Ranando Hollow Run			200
Laubachs, Hess Spring Creek			100
Wymans Brook			100
Leola, Carpenter's run			1,200
Groffs Run			1,200
Leslie Run, Leslie Run			1,300
Shaffers Run			200
Lewisburg, Bull Run			200
Lewistown, Alafrata Run			275
Strode Run			275
Lilly, Bens Creek			200
Blairs Creek			200
McHugh Creek			200
Lititz, Middle Creek			1,600
Stony Creek			300
McAuley, Tidewater Pond			500
Mahaffey, Beaver Run			225
Boiling Spring Run			225
Campbell Run			225
Curry Run			225
Deer Run			225
Hazlett Run			225
Laurel Run			225
Lick Run			225
McCracken Run			225
McGees Run			225
Rock Run			225
Rogue Harbor Run			225
Sawmill Run			225
Snyder Run			225
Whisky Run			225
Wilson Run			225
Mainville, Furnace Run			100
Mapleton, Beach Run			700
Campbells Creek			1,400
Chilcotts Run			700
Glasgows Creek			700
Greenlands Run			700
Laurel Run			1,400
Proughs Branch			700
Scrub Run			1,400
Smiths Mill Run			700
Snopps Run			700
Swopes Branch			700
Trough Creek			1,400
Marietta, Duffy Creek			400
Dugan Run			400
Evans Creek			600
Marsh Creek, Asaph Run			1,500
Marsh Creek			1,500
Strait Run			1,000

DISTRIBUTION OF FISH AND FISH EGGS, BY LOCALITY AND SPECIES, FISCAL YEAR 1913—Continued.

BROOK TROUT—Continued.

Disposition.	Eggs.	Fry.	Fingerlings, yearlings, and adults.
Pennsylvania—Continued.			
Mauch Chunk, Dill Down Creek			500
Mud Run			1,000
Mayburg, Bopps Creek			300
Mill Hall, Fox Hollow Creek			200
Panther Run			300
Minersville, Black Creek			200
Buckhorn Creek			200
Dyer Run			200
Montoursville, Loyalsock Creek			100
Mount Union, Boohers Gap Run			700
Carmichael Branch			700
Carters Run			1,400
Licking Creek			1,400
Long Hollow Run			1,400
Old Womans Gap Run			1,400
Roaring Run			700
Roberts Run			1,400
Scrub Gap Run			1,400
Singers Gap Run			1,400
New Ringgold, Irish Run			280
Newville, Laurel Run			1,125
Nisbet, Bender Run			200
Nordmont, Bashley Run			100
Birch Creek			100
Cherry Run			100
Deep Hollow Run			100
Dutchman Run			100
Elk Run			100
Ellison Run			100
Falls Run			100
Floodwood Run			100
Fritz Run			100
Gansell Run			100
Glass Creek			100
Hunter Run			100
Lake Run			100
Loyalsock Creek			200
Main Branch			100
Mill Creek			100
Moss Run			100
Muncy Creek			100
Oub Leb Run			100
Pond Branch			100
Public Run			100
Rock Run			100
Rusty Run			100
Shanerberg Run			100
Slip Run			100
South Branch			100
Spicewood Run			100
Spring Run			100
Suman Run			100
Oil City, Cherry Run			300
Holman Run			150
Horse Creek			300
Muskrat Run			300
Pithole Creek			300
Stewarts Run			300
Orviston, Big Run			500
Big Run, Middle Branch			500
Hayes Run			500
Marsh Creek, North Fork			500
Two Run Creek			500
Walker Branch			500
Palmerton, Blue Mountain Creek			280
Penfield, Bear Camp Run			400
Penllyn, Hoover's lake			1,000
Philipsburg, Ardells Run			600
Barkers Run			600
Bark Shed Run			600
Beaver Run			700
Benners Run			600
Bigelow Run			700
Big Spring Run			600
Bilgers Run			600

DISTRIBUTION OF FISH AND FISH EGGS, BY LOCALITY AND SPECIES, FISCAL YEAR 1913—Continued.

BROOK TROUT—Continued.

Disposition.	Eggs.	Fry.	Fingerlings, yearlings, and adults.
Pennsylvania—Continued.			
Philipsburg, Black Bear Run			700
Black Moshannon Creek			600
Bushkill Creek			5,500
Butlers Run			600
California Run			600
Clover Run			600
Cold Springs Run			600
Cold Stream Creek			3,000
Cold Stream Pond			700
Corbin Run			600
Curry Run			600
Dayton Run			600
Deep Rock Run			600
Echo Run			700
Flat Rock Run			600
Forge Run			600
Four Mile Run			600
Hutton Run			600
Huzzards Run			700
Laurel Run			600
Little Beaver Run			600
McCords Run			600
Moravian Run			600
Morgan Run			600
Nasons Run			600
North Run			700
One Mile Run			700
Pine Run			600
Potters Run			600
Sensers Run			600
Seven Springs Run			600
Shields Run			600
Six Mile Run			600
Slate Run			600
Sleepy Hollow Run			700
Smays Run			700
Splash Run			600
Spruce Run			600
Star Mill Run			600
Sterling Run			600
Tomahawk Run			600
Tom Tit Run			600
Trout Run			600
Turtle Spring Run			600
Twiggs Run			600
Vails Run			600
Winburne Run			600
Wolf Run			600
Picture Rocks, Big Run			300
Laurel Run			300
Lick Run			200
Roaring Run			200
Rock Run			300
Pottsville, Adam's run			500
Black Creek			500
Cold Run			300
Deep Creek			2,000
Dyer's run			500
Indian Run			500
Long Run			300
Schaffer Creek			2,000
Pottstown, Powderdale Creek			280
Quarryville, Conowingo Creek			2,000
Muddy Run			1,200
Octararo Creek, branch of			1,200
Ralston, Abbott Run			100
Acid Run			100
Bear Trap Run			100
Elk Lick Run			100
Heilman Run			100
Hound Run			100
Long Run			100
Mill Run			100
Miners Run			100
Pleasant Run			300

DISTRIBUTION OF FISH AND FISH EGGS, BY LOCALITY AND SPECIES, FISCAL YEAR 1913—Continued.

BROOK TROUT—Continued.

Disposition.	Eggs.	Fry.	Fingerlings, yearlings, and adults.
Pennsylvania—Continued.			
Ralston, Potash Run			100
Rock Run			300
Rock Run, Right Fork			200
Short Run			100
Slack Run			100
Wolf Run			100
Yellow Dog Run			100
Reading, Big Cacoosing Creek			200
Brunacle Creek			200
Little Cacoosing Creek			100
Mill Creek			200
Neversink Creek			200
Plum Creek			100
Six Penny Creek			100
Willow Creek			100
Wyomissing Creek			5,000
Reedsville, Alexander Run			500
Coffee Run			500
Havice Valley Run			1,000
Honey Creek			1,000
Kishacoquillas Creek			1,000
Lancaster Valley Creek			1,000
Laurel Run			1,000
Lingle Run			500
Peachey Run			1,000
Tea Creek			500
Treasters Run			1,000
West Branch			1,000
Rhoads Station, Clarks Run			220
Jonathan Run			165
Wallace Run			275
Rockport, Indian Run			1,200
Rapps Creek			1,200
Shaffer's run			1,000
Taylors Run			200
Roulette, Curd Creek			1,000
Fish Hollow Creek			1,000
Fishing Creek			1,500
Fishing Creek, East Branch			1,000
Fishing Creek, Spencer Branch			1,000
Lanigar Creek			1,000
Reed Run			1,000
Sartwell Creek			1,500
Trout Brook			1,000
Royersford, Mancill's run			140
Pine Swamp Creek			140
Powdermill Run			140
Royal Spring Creek			140
St. Marys, Big Run			200
Dents Run			225
Hellfire Run			225
Hicks Run			500
Little Dents Run			300
Little Wolf Lick Run			300
Sand Lick Run			225
Sawdust Run			225
Trout Run			300
Trout Run, Park Branch			300
Trout Run, Ten Acre Branch			300
Wolf Lick Run			300
Scranton, Roaring Brook			400
Shenandoah, Mud Run			200
Slate Run, Bolden Run			1,000
Callahan Run			1,500
Cedar Run			2,000
County Line Branch			1,000
Cushman Creek			500
Cushman Fork Run			2,000
Daugherty Run			1,500
Dyer Branch Run			1,000
Frances Creek			500
Jacobs Run			1,000
Little Slate Run			1,500
Manor Fork Run			1,500
Morris Run			2,000

DISTRIBUTION OF FISH AND FISH EGGS, BY LOCALITY AND SPECIES, FISCAL YEAR 1913—Continued.

BROOK TROUT—Continued.

Disposition.	Eggs.	Fry.	Fingerlings, yearlings, and adults.
Pennsylvania—Continued.			
Slate Run, Nabal Run			1,500
Otter Run			500
Pine Creek			2,000
Pine Bottom Creek			1,000
Red Run			1,500
Slate Run			2,000
Trout Run			2,000
Willcox Run			1,000
Spartansburg, Spring Creek			300
Stroudsburg, Bear Lick Creek			350
Broadhead Creek, East Branch			350
Broadhead Creek, Levis Branch			350
Broadhead Creek, West Branch			350
Browns Run			280
Buck Hill Creek			350
Little Bushkill Creek			350
Marchells Creek			350
Mill Creek			350
Pocono Creek			210
Saw Creek			350
Spoke Factory Run			210
Stony Run			350
Tionesta, Bates Run			150
Bear Creek			150
Big Coon Creek			150
Council Run			150
Davis Run			150
Dawson Run			150
Fork Run			150
Hunter Run			150
Jakes Run			150
Jamison Run			150
Johns Run			150
Jug Handle Run			150
Korb Run			150
Lamentation Run			150
Laurel Run			450
Little Coon Creek			150
Little Hickory Creek			150
Little Tionesta Creek			150
McCarthy Run			150
Mix Run			450
Peters Run			150
Pigeon Run			150
Piney Run			300
Rath's run			150
Recks Run			150
Ross Run			150
Sibble Run			150
Sugar Run			150
Tubs Run			150
Vockroth Run			150
West Hickory Creek			150
Titusville, Abbey Run			150
Armstrong Brook			150
Barton Run			150
Beaver Run			150
Bowers Run			75
Duffield Run			150
Foster Run			75
Gillespie Run			150
Glaspy Run			150
Glen Run			150
Grove Run			75
Haworth Run			150
Hindle Run			75
Little Oil Creek			150
McKay Run			75
McKenzie Run			75
Myers Run			75
Noel Run			150
Pithole Creek, West Branch			150
Prenatt's run			75
Richey Run			75

DISTRIBUTION OF FISH AND FISH EGGS, BY LOCALITY AND SPECIES, FISCAL YEAR 1913—Continued.

BROOK TROUT—Continued.

Disposition.	Eggs.	Fry.	Fingerlings, yearlings, and adults.
Pennsylvania—Continued.			
Titusville, Sheffers Run			75
Shirley Run			150
Smith Run			75
Sugar Creek and branches			975
Three Bridge Run			150
Vincent Run			225
Welsh Run			75
Woodcock Run			150
Tobyhanna, Kessler Run			210
Polly's run			140
Tobyhanna Creek			280
Trout Run, Black's creek			1,000
Flook's run			1,000
Four Mile Run			1,000
Gray's run			300
Little Pine Creek and tributaries			500
Miller Run			500
Six Mile Run			1,000
Trout Run			1,000
Troy, Becker Run			100
Brandy Run			100
Bullard Creek			100
Chaces Run			100
Cleveland Run			100
Covert Creek			100
Fall Brook			100
Fellows Creek			100
Forbes Creek			100
Griffin Creek			100
Keith Creek			100
Kiff Creek			100
Kinnon Run			100
Little Falls Creek			100
Miller Run			100
Morgan Creek			100
Morris Run			100
Palmer Run			100
Rathbone Creek			100
Sherman Run			100
Sylvan Run			100
Tamarack Run			100
Webber Creek			100
Wilkins Run			100
Tryonville, Olson Creek			300
Tyler, Little Laurel Run			220
Waterville, Bark Cabin Run			100
Bear Run			100
Bonnell Run			100
Buckeye Branch			400
Carson Run			100
Coal Run			100
English Run			100
Little Pine Creek			100
Otter Run and tributaries			400
Pine Run			100
Pine Bottom Creek			100
Rogers Run			100
Waynesboro, Antietam Creek			110
Antietam Creek, West Branch			110
Cascade Run			110
Mackeys Run			220
Old Forge Run			110
West Chester, Chester Creek			1,500
Lady Run			350
Little Broad Run			500
Taylors Run Lake			1,000
West Grove, White Clay Creek			1,200
Weissport, Mahoning Creek			210
Sawmill Creek			140
White Rock, Walker's run			400
Williamsburg, Canoe Creek			165
Clover Creek			165
Fox Run			165
Piney Creek			165
Reservoir Run			165

DISTRIBUTION OF FISH AND FISH EGGS, BY LOCALITY AND SPECIES, FISCAL YEAR 1913—Continued.

BROOK TROUT—Continued.

Disposition.	Eggs.	Fry.	Fingerlings, yearlings, and adults.
Pennsylvania—Continued.			
Williamsport, Big Bear Creek			1,000
Lycoming Creek			8,000
Mill Creek and tributaries			3,000
Windber, Berkeybile Run			200
Big Paint Creek			200
Bolls Creek			200
One Mile Run			200
Racing Fork Creek			200
Seese Creek			200
Winburne, Black Bear Run			2,000
Black Moshannon Creek			2,000
South Carolina:			
Walhalla, Howards Creek			150
South Dakota:			
Big Bend, Prairie Creek			12,000
Buffalo, Jones Creek			8,000
Cavite, White River			20,000
Deadwood, Spruce Creek			8,000
Elmore, Ice Box Canyon Creek			13,000
M. and M. Creek			10,000
Spearfish Creek, South Branch			12,000
Spearfish River			50,000
Squaw Creek			12,000
Wildcat Creek			10,000
Englewood, Chipmunk Creek			5,000
Jim Creek			600
Spearfish Creek, Goddard Branch			5,000
Spearfish Creek, South Fork			5,000
Galena, Bear Butte Creek			20,000
Hermosa, Squaw Creek			20,000
Hot Springs, Palmer Lake			400
Nemo, Box Elder Creek			25,000
Pactola, Gilbert's pond			5,000
Presho, Medicine Creek			5,000
Rapid City, Rapid Creek		25,000	
Rockford, Castle Creek, North Fork			12,000
Castle Creek, South Fork			8,000
Little Rapid Creek, West Fork			18,000
Rapid Creek			250
St. Onge, Lower False Bottom Creek			5,000
Savoy, Spearfish Creek			20,000
Spearfish, Cook Creek			15,000
Crow Creek			2,500
Franklin Run			10,000
Helmers Spring Branch			12,000
Higgens Gulch Creek			5,000
Hilton Gulch Creek			10,000
Hosser Creek			3,000
Hosser Creek, Murray Branch			3,000
Johnson Creek			2,500
Jones Spring Branch			3,000
Linley Spring Branch			3,000
McGoffin Creek			12,000
McGregor Creek			12,000
Miller Creek			12,000
Normal Lake			10,000
Smith Spring Creek			8,000
Spearfish Creek			23,000
Spring Branch			10,000
Willow Creek			5,000
Sturgis, Warren Creek			600
Sundance, Houston Creek			15,000
Morgan's creek			3,000
North Miller Creek			18,000
South Miller Creek			18,000
Tilford, Morse Creek			15,000
Tennessee:			
Dante, Donaldson Spring Branch			1,200
Knobs Fork Creek			2,000
Gray, Cox's branch			1,200
Hodge's branch			5,000
Hampton, Laurel Fork Creek			9,100
Johnson City, Hart's pond			225
Wofford's pond			1,000

DISTRIBUTION OF FISH AND FISH EGGS, BY LOCALITY AND SPECIES, FISCAL YEAR 1913—Continued.

BROOK TROUT—Continued.

Disposition.	Eggs.	Fry.	Fingerlings, yearlings, and adults.
Tennessee—Continued.			
Roan Mountain, Doe River and tributaries			6,000
Townsend, Forge Creek			6,000
Little River			18,000
Mill Creek			6,000
Rabbit Creek			6,000
Utah:			
Ogden, Coldwater Pond			1,000
Randolph, Bear Lake			12,000
Vermont:			
Arlington, Battenkill River		6,000	
Beaver Brook			1,000
Hopper Brook			1,000
Lid Hollow Brook			1,000
South Fork Creek			1,000
Whitman Brook			700
Barton, Barton River		15,000	
Barre, White River Branch			5,700
Beebe Junction, Brainard Brook		3,000	
Johns River		6,000	
Studdub Brook		4,000	
Bellows Falls, Morse Brook		5,000	
Bennington, Basin Brook		3,000	
Bickford Hollow Brook		3,000	
Big Hell Hollow Brook		3,000	
Brown Brook		3,000	
Bushnell Brook		3,000	
Chase Brook		3,000	
Chase Brook No. 2		3,000	
City Stream		3,000	
Dewey Brook		3,000	
Dunville Stream		5,000	
Evans Brook		3,000	
Furnace Brook		5,000	
Glastenbury Stream		3,000	
Little Hell Hollow Brook		3,000	
Perre Thompson Brook		3,000	
Rider Brook		3,000	
Roaring Branch		5,000	
Rockwood Brook		3,000	
South Stream		5,000	
Stachia Brook		3,000	
Stratton Brook		3,000	
Walters Brook		3,000	
Wallomsac River		5,000	
Webb Brook		3,000	
Bloomfield, Dennis Pond			500
Brandon, Mill River			500
Sugar Hollow Brook, East Branch			2,000
Brattleboro, Ames Hill Brook			700
Broad Brook			1,000
Jacobs Brook			700
Meadow Brook			500
Putney Falls Brook			700
Stark Brook			500
Bristol, New Haven River			1,500
Canaan, Forest Brook		5,000	
Forest Lake		10,000	
Lewis Pond		10,000	
Little Averill Lake		10,000	
Nulhegan Stream		10,000	
Roaring Brook		5,000	
Clarendon, Tinmouth River			1,250
Cuttingsville, Shrewsbury Pond			1,500
Danville, Joe's brook		5,000	
East Clarendon, Morin Pond			1,000
East Dorset, Meadow Brook		9,000	
East Putney, Putney Hollow Brook			4,000
Edgewater, Kelley Brook		3,000	
Lanesboro Brook		5,000	
Niggerhead Pond		20,000	
Niggerhead Ledge Brook		4,000	
Ely, Bannock Brook		5,000	
Enosburg Falls, Bakersfield Brook			2,000
Brady Brook			1,000
Cold Hollow Brook			2,000

DISTRIBUTION OF FISH AND FISH EGGS, BY LOCALITY AND SPECIES, FISCAL YEAR 1913—Continued.

BROOK TROUT—Continued.

Disposition.	Eggs.	Fry.	Fingerlings, yearlings, and adults.
Vermont—Continued.			
Enosbury Falls, Ladd Brook			1,000
Mineral Spring Brook			1,000
Sand Hill Brook			2,000
Stoneville Brook			1,000
Greensboro, Caspian Lake			6,400
Lamoille River		5,000	
Long Pond Brook		5,000	
Porter Brook		8,000	
Taylor Brook		5,000	
Groton, Darling Pond		100,000	20,000
Hardwick, Bailey Brook		5,000	
Bunker Brook		5,000	
Paine Brook		5,000	
Porter Brook		5,000	
Holden, Clover Vale Brook		10,000	
Crandall Brook			10,000
Elliott Run			5,000
Furnace Brook		50,000	
Hyde Park, Corey Pond		10,000	
Island Pond, Buck Brook		5,000	
Carroll Brook		5,000	
Dalloff Brook		5,000	
Ferrin River		10,000	
Mill Brook		5,000	
Nulhegan River		10,000	
Nulhegan River, North Branch		10,000	
Ossogochee Brook		5,000	
Pay Brook		5,000	
Smith Brook		5,000	
Thompson Brook		5,000	
Yellow Branch		8,000	
Jamaica, Bald Mountain Brook			1,500
Johnson Brook			700
Kidder Brook			1,000
Pikes Falls Brook			1,500
Jericho, Lee River		10,000	
Johnson, Gibson Brook		10,000	
Lanesboro, Bennett's pond		10,000	
Lyndon, Gilbert Brook		5,000	
Hawkins Brook		8,000	
Houghton Brook		6,000	
Sheldon Brook		5,000	
South Wheelock Brook		10,000	
Lyndonville, Willow Pond			5,500
Manchester, Battenkill River		15,000	1,000
Battenkill River, West Branch			6,250
Dorset Creek			5,000
Lye Brook			1,000
Paulet River			1,000
West Brook			1,000
Marshfield, Carpenter Brook			500
Kenney's pond		20,000	
Niggerhead Brook		4,000	
Ormsbee Brook		4,000	
Middlebury, Hendrick Brook			500
Mills Brook			2,000
North Branch			500
Middlesex, Long Brook		6,000	
Montpelier, Bennett's brook		5,000	
Dog Pond Brook		3,000	
Dwinell Brook			1,000
East Roxbury Pond		20,000	500
Mallory Brook		5,000	
Shady Rill Brook		5,000	
Verge Pond			1,250
Williamstown Gulf Branch			4,000
Morrisville, Bugbee Brook		2,000	
Burke Brook		2,000	
Darling Brook		3,000	
McNall Brook		5,000	
Terrill Brook		5,000	
Newport, Burgoine Brook		5,000	
North Bennington, Brown Brook		3,000	
North Dorset, Bebee Brook		5,000	

DISTRIBUTION OF FISH AND FISH EGGS, BY LOCALITY AND SPECIES, FISCAL YEAR 1913—Continued.

BROOK TROUT—Continued.

Disposition.	Eggs.	Fry.	Fingerlings, yearlings, and adults.
Vermont—Continued.			
Northfield, Bull Run Brook		4,000	
Mudgett's brook		3,000	
Norwich, Cassingham Brook		3,000	
Dotham Brook		5,000	
Goodrich Brook		5,000	
Lake Mitchell		50,000	18,000
Mary Jarvis Brook		3,000	
New Boston Brook			2,000
Whitcomb Brook		3,000	
Orleans, Brighton Brook		3,000	
Dewey Brook		3,000	
Dutton Brook		5,000	
Gallup Brook		5,000	
Long Pond		10,000	
Missisquoi River		25,000	
Perry Brook		4,000	
Willey Creek		6,000	
Willoughby Lake		5,000	
Willoughby River		10,000	
Pittsford, Cooley Creek		5,000	
Furnace Brook, West Branch		5,000	
Plainfield, Beaver Brook		5,000	
Lye Brook Pond			500
Pigeon Pond, tributary		6,000	
Poultney, Poultney River			8,000
Proctorsville, Twenty-Mile Brook			4,000
Williams River			10,000
Randolph, Adams Brook		4,150	
Alco Pond		10,000	
Annis Brook		3,000	
Ayers Brook			6,000
Bass Brook		4,150	
Bear Hill Brook		3,000	
Blanchard Brook		3,000	
Bowman Brook		3,000	
Chandler Brook		4,150	
Clough Brook		3,000	
Cold Spring Brook			1,000
East Hill Brook		3,000	
Eldredge Brook		3,000	
Fishers Brook		3,000	
Guild Brook		3,000	
Gulf Brook		5,000	
Halfway Brook		8,000	
Holman Brook		4,150	
Howard Hill Brook		3,000	
Mafeba Lake			1,700
Meadow Brook		3,000	
Morse Brook		4,150	
Mud Pond			1,000
Peth Brook		4,150	
Poverty Lane Brook		3,000	
Purney Brook			1,000
Riford Brook			2,500
Roods Brook		3,000	
Roxbury Brook		3,000	
Snow's brook			700
Soper Brook		4,100	
Spears Brook		3,000	1,000
White River, Middle Branch		16,000	
White River, Randolph Branch		10,000	
White River, tributaries		5,000	
Rocky Point, Little Osmer Brook		4,000	
Stillwater Brook		5,000	
Rutland, Atwood Brook		4,000	1,000
Blueberry Hill Brook		5,000	
Britton Brook		5,000	1,000
Britton Pond		15,000	
Castleton River		15,000	
Cold River, South Branch			1,000
Connor Brook		3,000	1,250
Dim's brook			1,250
Dunkley's brook			1,700
Eddy Mill Brook			1,000
Hewitt Brook			1,000

DISTRIBUTION OF FISH AND FISH EGGS, BY LOCALITY AND SPECIES, FISCAL YEAR 1913—Continued.

BROOK TROUT—Continued.

Disposition.	Eggs.	Fry.	Fingerlings, yearlings, and adults.
Vermont—Continued.			
Rutland, Kill Brook			3,000
Mill River			2,000
Phillip's brook		5,000	
Roger's brook			2,000
Spooner Brook		5,000	
Spring Lake		20,000	
Wheeler Brook		5,000	1,000
St. Johnsbury, Blodgett Brook		3,000	
Clay Hill Brook		5,000	
Frog Pond		3,000	
Lawrence Pond		5,000	
Sleepers River, West Branch		5,000	
Sleepers River, Wheelock Branch		25,000	
State fish commission		50,000	
Sharon, Fales Pond			1,250
Lake Mitchell		50,000	
Willow Pond			300
Shelburne, Greystone Pond			500
South Ryegate, Baileys Pond		5,000	
Mount Pleasant Pond		5,000	
Stowe, Lake Mansfield			5,485
Sunderland, Battenkill River			1,250
Beaver Meadows Brook			1,000
Dyer Brook			700
Lathrop Brook			1,000
Lye Brook			1,250
Tanner Brook			700
Taftsville, Beaver Brook			800
Townshead, Main Brook			2,000
Waterbury, Lake Mansfield		20,000	
West Burke, Beaver Brook			1,000
West Hartford, Jericho Brook		4,000	
Little Brook			1,700
Podunk Brook			2,000
Porter Brook			2,000
Rockland Brook			700
Sawyer Brook			700
Sherburne-Warren Brook			3,000
Sunny Brook			1,000
Tiger Town Brook		4,000	
Woodland Farm Brook		3,000	
Weston, Lake Wantastiquet		35,000	
West Townsend, Acton Brook			1,000
Carr Brook			1,000
Silver Brook			700
Wilmington, Ballou Brook and tributaries			2,000
Woodstock, Black Pond			1,500
Bridgewater Brook			700
Brook-Farm Brook			2,000
Deerin Ponds			1,000
English Mills Brook			3,000
Grey Camp Trout Pond			700
Happy Valley Brook			700
Mecawe Lake			12,000
Pomfret Brook			500
Virginia:			
Arrington, Elk Creek			1,000
Big Island, Battery Creek			1,500
Snow Creek			300
Buena Vista, Stations Creek			200
Clairmont, Marion Brook			200
Clifton Forge, Wilson Creek			2,000
Covington, Mill Run			200
Dayton, Cooks Creek			400
Eagle Mountain, Patterson Creek			1,750
Edinburg, Evans's pond			200
Elgin, Piny Run			2,000
Fredericksburg, Baldwin's run			500
Hess Run			200
Front Royal, Happy Creek			300
Herndon, Rocky Run		10,000	400
Hot Springs, Francisco Spring Branch			100
Indian Rock, North Creek			1,250
Mount Jackson, Glorif Run			6,000
Laurel Dale, White Top Creek			3,100

DISTRIBUTION OF FISH AND FISH EGGS, BY LOCALITY AND SPECIES, FISCAL YEAR 1913—Continued.

BROOK TROUT—Continued.

Disposition.	Eggs.	Fry.	Fingerlings, yearlings, and adults.
Virginia—Continued.			
Leesburg, Big Spring Branch		9,400	
Leonards, Wolf Run			300
Lexington, Buffalo River, South Fork			200
Luray, Jeremy's run			800
Millboro, Big Spring Creek			6,000
Palmyra, Taylor's pond			1,000
Richmond, Burke's pond			100
Rural Retreat, James Creek			300
Shanklin, Little Back Creek			500
Washington:			
Birdsview, Mill Creek			900
Boyds, Deadman Creek			600
Colfax, South Palouse River			600
Elma, Cloquallum Creek		2,000	
Goldendale, Scammon's pond		3,000	
Guy, South Palouse River			840
Keechelus, Lake Keechelus			1,200
Metaline Falls, Sullivan Lake			800
Newport, Davis Creek			400
Republic, Long Lake			400
Seattle, Collin's pond		4,000	
Laurel Creek		2,000	
Snoqualmie River, Middle Fork			600
Snoqualmie River, North Fork			600
Snoqualmie River, South Fork			600
Tarboy, San Pail Lake			400
Walla Walla, Hawthorne Brook		2,000	
West Virginia:			
Belington, Hunters Fork Creek			400
Johnsons Mill Pond			400
Bluefield, Paoliello's pond			1,000
Burner, Club House Run			2,000
Harper Run			2,000
Little River			2,000
Span Oak Run			2,000
Cass, Cheat River			2,000
Deer Creek			500
Clover Lick, Clover Creek			2,000
Laurel Run			280
Coalton, Roaring Creek			500
Durbin, Lambert Run			500
Fayette, Wolf Creek			780
Harman, Dove's pond			490
Horton, Big Run			2,660
Greenbrier River, West Fork			1,400
Laural Fork Run			1,400
Seneca Creek			2,100
Teter Camp Run			700
Keyser, New Creek			2,000
Marlinton, Cochrans Creek			500
Dauthord's creek			2,500
Laurel Creek			300
Williams River			1,250
May, Greenbrier River, tributary			400
Orndorf Creek			400
White Camp Creek			400
Midvale, Cassity Creek			9,000
Kettle Creek			9,000
Middle Fork Creek			14,000
Pleasant Run			9,000
Stone Coal Creek			9,000
Morgantown, Coburn Creek			400
Seebert, Cranberry River			2,000
Sitlington, Sitlington Creek			500
Spangler, Conley Run			500
White Sulphur Springs, Howard Creek			2,400
Winterburn, Greenbrier River			1,000
Little River			1,000
Long Run			1,950
Wisconsin:			
Alma, Alitz Creek			500
Balk's creek			500
Baums Valley Creek			100
Big Waumandee Creek			2,000
Braem's creek			500

DISTRIBUTION OF FISH AND FISH EGGS, BY LOCALITY AND SPECIES, FISCAL YEAR 1913—Continued.

BROOK TROUT—Continued.

Disposition.	Eggs.	Fry.	Fingerlings, yearlings, and adults.
Wisconsin—Continued.			
Alma, Deer Creek			500
Gaeble Creek			500
Hutchison Creek			500
Johns Valley Creek			2,100
Kaste's creek			500
Lee Valley Creek			500
Leonhardy Creek			500
Little Waumandee Creek			2,100
Mill Creek			500
Mueller's creek			500
Netting Creek			500
Norwegian Valley Creek			2,000
Pine Creek			600
Piper Valley Creek			2,000
Risch Creek			500
Schaub's creek			500
Schoeppy's creek			500
Schmidt Creek			500
Schultz Creek			500
Spring Creek			500
Tamarack Creek			500
Trout Creek			500
Trout Valley Creek			2,000
Waumandee Creek			100
Wingert Creek			500
Amery, Bear Creek			190
Athens, Black Creek			570
Augusta, Bear Grass Creek			4,000
Beef River, North Branch			200
Coon Fork Creek			200
Hay Creek			200
Horse Creek			200
Travis Creek			200
Baldwin, Rush River			2,500
Black River Falls, Allen's creek			500
Amundson Creek			500
Bacon Creek			1,000
Clear Creek			500
Douglas Creek			1,000
Gebhart Creek			1,000
Kenyon Creek			500
Levis Creek, South Branch			500
Morey Creek			500
Moseley Creek			500
Pappoose Creek			500
Peterson Run			500
Roaring Creek			1,000
Slosser Creek			1,000
Smith Creek			500
Snow Creek			500
Stein Creek			500
Stony Creek			1,000
Thompson Creek			500
Town Creek			500
Trout Run			1,000
Van Hersett Creek			500
Visneau Creek			500
Blair, Fly Creek			200
Johnson Coulee Creek			300
Lake Coulee Creek			300
Matson Creek			200
Reynolds Creek			300
Salva Coulee Creek			200
Shephard Creek			300
Strums Creek			200
Tippen Coulee Creek			200
Trump Coulee Creek			200
Vasse Coulee Creek			200
Welch Coulee Creek			300
Bloomer, Duncan Creek			380
McCann Creek			3,380
Sand Creek			3,380
Trout Creek			3,190
Blue Mounds, Camp Creek			5,000
Frances Creek			5,000
Garfort Creek			5,000
Ryan's creek			5,000

DISTRIBUTION OF FISH AND FISH EGGS, BY LOCALITY AND SPECIES, FISCAL YEAR 1913—Continued.

BROOK TROUT—Continued.

Disposition.	Eggs.	Fry.	Fingerlings, yearlings, and adults.
Wisconsin—Continued.			
Boyd, Black Creek			2,000
Jackson Creek			2,000
Jenneman Creek			2,000
Kuhn Creek			2,000
Muskrat Creek			2,000
Pinter Creek			2,000
Schaller Creek			2,000
Swanson Creek			2,000
Turner's creek			2,000
Brule, Brule River			8,950
Sand Creek			3,000
Spring Creek			3,000
Wheaton Creek			190
Cable, Big Brook			5,000
Namekagon River			570
Twin Brooks			3,000
Carson, Douglas Creek			160
Foster Brook			160
Fur Creek			160
Hoffman Creek			160
Little Coon Creek			160
Rowes Creek			160
Cashton, Bohemian Valley Creek			500
Brush Creek			500
Cannon Valley Creek			500
Coles Valley Creek			500
Coon Creek			500
Gronouns Creek			500
Halls Valley Creek			500
Hay Creek			500
Jersey Stream			500
Lyons Valley Creek			500
Manspi Valley Creek			500
Meisner Brook			500
Paulson Brook			500
Pleasant Valley Creek			500
Plum Valley Creek			500
Russell Valley Creek			500
Speck Brook			500
Timber Valley Creek			500
Twenty Four Valley Creek			500
Witchman Brook			500
Chetek, Moose Ear Creek			570
Colfax, Bronken Creek			1,500
Cumberland, Clam River			1,000
Clam River, North Fork of South Fork			1,000
Hickey Creek			1,000
McKenzie River			1,000
Miller Creek			1,000
Sand Creek			1,000
Spring Brook			1,000
Spring Creek			1,000
Yellow River			1,000
Dodgeville, Furnace Branch			1,500
Durand, Big Arkansaw Creek			300
Brennig Creek			3,000
Herron Creek			2,000
Little Arkansaw Creek			3,000
York Creek			2,000
Eagle River, Seven Pail Creek			2,000
Eau Claire, Alder Creek			600
Alphonse Creek			500
Apple Creek			1,000
Ash Creek			1,000
Awnsie Creek			1,000
Badger Creek			1,000
Balsam Creek			500
Beaver Creek, North Fork			500
Beaver Falls Creek			500
Beech Creek			500
Bessie Creek			1,000
Birch Creek			1,500
Branshaw Creek			500
Brogan Creek			1,000
Cat Creek			1,000
Charles Creek			1,000

DISTRIBUTION OF FISH AND FISH EGGS, BY LOCALITY AND SPECIES, FISCAL YEAR 1913—Continued.

BROOK TROUT—Continued.

Disposition.	Eggs.	Fry.	Fingerlings, yearlings, and adults.
Wisconsin—Continued.			
Eau Claire, Conklin Creek			1,000
Daisy Creek			1,000
Dale Creek			500
David Creek			1,000
Deans Creek			1,500
Deer Creek			500
Dodge Creek			500
Downs Creek			1,000
Elinore Creek			1,000
Ella Creek			1,500
Evans Creek			1,000
Fern Creek			1,500
Fish Creek			1,000
Fletcher Creek			1,000
Four Mile Creek			500
Gladys Creek			1,000
Gold Creek			500
Gorton Creek			1,000
Grace Creek			500
Graham Creek			500
Grape Creek			1,000
Grassy Creek			500
Gray Creek			500
Hair Creek			1,000
Hansens Creek			500
Iron Creek			500
Jackson Creek			500
Jacobson Creek			1,000
Jeskie Creek			1,000
Jim Creek			1,000
Junior Creek			1,000
Kelly Creek			1,000
Lamb Creek			1,000
Lillie Creek			1,000
Little Rock Creek			500
Long Creek			500
Louis Creek			1,000
Lowe's creek			1,000
McCann Creek			1,000
Maple Creek			500
Mink Creek			500
Minnie Creek			500
Moon Creek			1,000
Mud Creek			500
Muskrat Creek			500
Niagara Creek			500
Nine Mile Creek			1,000
North Creek			500
One Mile Creek			500
Otto Creek			500
Peach Creek			1,000
Pebble Creek			1,000
Penn Creek			1,000
Pine Creek			500
Pussie Creek			1,000
Rainbow Creek			500
Ridge Creek			1,000
Rilette Creek			1,000
Rock Creek			500
Sandy Creek			500
Sharp Creek			1,000
Sheep Creek			1,000
Sherman Creek			1,000
Spring Creek			500
Squirrel Creek			500
Stony Creek			500
Stony Brook			500
Stout Creek			500
Ten Mile Creek			500
Thorson Creek			500
Trout Creek			1,000
Valley Brook			1,000
Violet Creek			1,000
Wessley Creek			500
Willow Creek			500
Wright's creek			1,000

DISTRIBUTION OF FISH AND FISH EGGS, BY LOCALITY AND SPECIES, FISCAL YEAR 1913—Continued.

BROOK TROUT—Continued.

Disposition.	Eggs.	Fry.	Fingerlings, yearlings, and adults.
Wisconsin—Continued.			
Eleva, Big Creek			4,000
Trout Creek			4,000
Ellsworth, Big Coulee Creek			900
Big River			1,350
Brush Creek			900
Cafe Creek			1,350
Carlson Spring Run			450
Cave Creek			900
Gilberts Spring Creek			900
Goose Creek			900
Isabelle Creek			1,350
Little Coulee Creek			900
Little Trimbelle Creek			1,350
Lost Creek			1,350
Murphy Spring Run			450
Rush River			1,800
South Fork Creek			1,350
Spring Brook			900
Trimbelle Creek			1,800
Ferryville, James Creek			100
Fountain City, Bohn Valley Creek			2,000
Bohris Valley Creek			100
Eagle Valley Creek			2,100
Hentger Valley Creek			100
Pine Creek			2,000
Piper Valley Creek			100
Schaffner Valley Creek			2,100
Foxboro, Big Balsam Creek			6,000
State Line Creek			4,000
Friendship, Fairbank's creek			1,500
Schoonover Creek			1,500
White Creek			800
Galesville, American Valley Creek			3,000
Bear Creek			1,000
Beaver Creek, North Branch			1,500
Beaver Creek, South Branch			1,000
Big Tamarack Creek			2,000
Corrigan's creek			1,000
Dutch Creek			4,000
Ettrich Creek			3,000
Fox Creek			2,000
Fox Coulee Creek			1,000
French Creek			4,500
Galloway Creek			1,000
Grant Creek			1,000
Hardie Creek			1,000
Holcomb Coulee Creek			4,000
Irish Valley Creek			3,000
Little Tamarack Creek			1,000
McCarthys Creek			1,000
Norway Coulee Creek			4,000
Norwegian Valley Creek			2,000
Silver Creek			3,000
Tamarack Creek			1,500
Glenwood City, Anderson Creek			500
Bellew Creek			500
Big Beaver Creek			500
Blues Creek			500
French Creek			500
Hay River, South Fork			500
Huggins Creek			500
Johns Creek			500
Little Beaver Creek			500
Little Bolen Creek			500
Owens Creek			500
Preschls Creek			500
Sand Creek, North Fork			500
Sand Creek, South Fork			500
Scotty's creek			500
Smiths Creek			500
Sullivan's creek			500
Tiffany Creek, North Fork			500
Tiffany Creek, South Fork			500
Vans Creek			500
Vierons Creek			500

DISTRIBUTION OF FISH AND FISH EGGS, BY LOCALITY AND SPECIES, FISCAL YEAR 1913—Continued.

BROOK TROUT—Continued.

Disposition.	Eggs.	Fry.	Fingerlings, yearlings, and adults.
Wisconsin—Continued.			
Greenwood, Davis Creek			200
Guile Creek			100
Rocky Run			200
Wayne Creek			100
Wedges Creek			200
Hillsboro, Cancutt Creek			400
Devils Run			400
Happy Hollow Creek			400
Meadow Brook			400
Silver Creek			400
Skunk Run			400
Slater Creek			400
Werner Creek			800
Werner Creek, branch of			400
Iron River, Hill Creek			4,000
Kendall, Brainard's creek			400
Davis Creek			400
Foxes Creek			400
La Crosse, Bohemian Creek			400
Chipmunk Creek			400
Coon Creek			800
Fishback Creek			400
Halfway Creek			800
Mormon Creek			800
Sand Lake Creek			400
Timber Creek			800
Mauston, Alder Creek			1,000
Bruer Creek			800
Fellond Creek			1,000
Gospel Point Creek			500
Indian Creek			1,000
Madden's creek			400
Mile Creek			800
Seven Mile Creek			800
Spring Creek			1,000
Medford, Beaver Creek			4,000
Melvina, Anderson Creek			400
Brown's creek			400
Cannon Valley Creek			400
Chamber's creek			400
Olson Creek			400
Schotten Valley Creek			400
Mellen, Devils Creek			4,000
McCarthy Creek			4,380
Minnon Creek			4,000
Montreal Creek			4,000
Penokee Creek			4,000
Silver Creek			4,000
Trout Brook			4,000
Tylers Fork River			4,000
Menomonie, Anderson Creek			200
Annis Creek			240
Asylum Creek			220
Balsbaugh Creek			200
Beaver Creek			200
Big Elk Creek			200
Big Hay Creek			400
Big Meadows Creek			200
Bishop Creek			200
Biss Creek			200
Blair Creek			200
Bolan Creek			200
Borlan I Creek			200
Clacks Creek			200
Coon Creek			200
Cowan Creek			200
Cranberry Creek			200
Denning Run			200
Drowley's run			200
Dushane Creek			400
Eau Galle River			400
Eddy Creek			200
Eighteen Mile Creek			200
Fall Creek			200
Galloway Creek			200
Gilbert Creek			400

DISTRIBUTION OF FISH AND FISH EGGS, BY LOCALITY AND SPECIES, FISCAL YEAR 1913—Continued.

BROOK TROUT—Continued.

Disposition.	Eggs.	Fry.	Fingerlings, yearlings, and adults.
Wisconsin—Continued.			
Menomonie, Hay River			400
Hay River, South Fork			400
Home Farm Run			200
Johns Creek			240
Iron Creek			240
Irvine Creek			400
Kings Creek			200
Knights Creek			200
Knipple Creek			240
La Forge Creek			200
Lambs Creek			200
Lambs Creek, North Fork			200
Little Beaver Creek			200
Little Elk Creek			200
Little Hay Creek			200
Little Missouri River			200
Little Otter Creek			200
Little Sand Creek			200
Losbys Run			200
Louis Creek			200
Lynch Creek			200
McCarthy Creek			200
Missouri River			200
Mud Creek			200
Palmer's run			200
Paradise Creek			200
Parker Run			200
Pine Creek			400
Popple Creek			200
Roach Creek			200
Rock Creek			200
Rush Creek			200
Sand Creek			200
Shafer Creek			200
Simonson Creek			200
Sinking Creek			200
Sly Creek			200
Smith Creek			200
Spring Creek			200
Stoner Creek			200
Thum Creek			200
Tiffany Creek			200
Trout Creek			200
Varney Creek			200
Webber Creek			200
White Creek			200
Wilcox Creek			240
Wilson Creek			240
Wilson Creek, North Branch			240
Wolfs Run			200
Merrill, Averill Creek			2,000
Barnes Creek			2,000
Copper River			2,500
Devils Creek			2,000
New Wood River			2,000
Pine River			2,500
Prairie River			2,500
Smith Creek			2,000
Millston, Alvard Creek			500
Baumel Creek			500
Clear Creek			500
Covey Creek			500
Dunham Creek			500
Eidsmoe Creek			500
Fisher Creek			500
Fisher Creek, South Fork			500
Gebhardt Creek			500
Gleus Creek			500
Houser Creek, East Fork			500
Indian Creek			500
Ketchum Creek			500
Lambert Creek			500
Larkin Creek			500
Mattison Creek			500
Pangratz Creek			500

DISTRIBUTION OF FISH AND FISH EGGS, BY LOCALITY AND SPECIES, FISCAL YEAR 1913—Continued.

BROOK TROUT—Continued.

Disposition.	Eggs.	Fry.	Fingerlings, yearlings, and adults.
Wisconsin—Continued.			
Millston, Pigeon Creek			500
Rudd Creek			500
Spring Creek			1,000
Stanton Creek			500
Stanton Creek, East Fork			500
Wyman Creek			1,000
Wyman Creek, East Fork			500
New Lisbon, Brewer Creek			800
Fairbanks Creek			800
Hoten Creek			800
Jackson Creek			800
Macomber Creek			800
Mead Creek			800
Northcott Brook			800
Rosland Creek			800
Schoonover Creek			800
Webster Creek			800
Newry, Coon Creek, branch of			2,000
Ellefson Spring Creek			1,000
Norwalk, Brunner Creek			2,000
Cook Creek			800
Devils Hollow Creek			400
Dreier Run			400
Farmers Valley Creek			800
Fels Creek			2,000
Moores Creek			800
Orienta, Reefer Creek			15,000
Pepin, Big Plum Creek			450
Bogus Creek			450
Bogus Creek, North Branch			450
Ell Creek			450
Ell Creek, North Branch			450
Little Plum Creek			450
Lost Creek			450
Lost Creek, West Branch			450
Porcupine Creek			450
Roaring River			450
Roaring River, East Fork			450
Sixteen Creek			450
Redgranite, Bruce Creek			2,000
Richland Center, Ash Creek			5,000
Big Bear Creek			5,000
Big Willow Creek			5,000
Brush Creek			10,000
Fancy Creek			5,000
Fancy Creek, East Branch			500
Hawkins Creek			5,000
Little Bear Creek			5,000
Little Willow Creek			5,000
Melancthon Creek			5,500
Mill Creek			5,000
Pine River, West Branch			5,000
Souls Creek			5,000
Water Villa Branch			2,000
Willow Creek			500
River Falls, Kinnickinnick Creek			2,250
Sparta, Beemer Creek			400
Parks Creek			800
Sopher Creek			3,000
Spring Valley, Burghardt Creek			700
Cady Creek			700
Cave Creek			500
Eau Galle River			1,400
French Creek			700
Gilbert Creek			1,400
Gilbert Creek, North Fork			700
Gilbert Creek, South Fork			700
Knights Creek			700
Loohns Creek			200
Lousy Creek			700
Mines Creek			700
Rush River			1,400
Stanley, Divine Creek			380
Swim Creek			4,000
Stone Lake, Big Godfrey Creek			5,000
Hay Creek			5,000
Sissibagama Creek			5,000

DISTRIBUTION OF FISH AND FISH EGGS, BY LOCALITY AND SPECIES, FISCAL YEAR 1913—Continued.

BROOK TROUT—Continued.

Disposition.	Eggs.	Fry.	Fingerlings, yearlings, and adults.
Wisconsin—Continued.			
Thorp, Bolin Creek			500
Chapman Creek			1,500
Sterling Creek			500
Tomah, Allen Creek			500
Bear Creek			900
Big Creek			600
Billings Creek			400
Brandy Creek			500
Brush Creek			500
Clear Creek			500
Clifton Creek			500
Coles Creek			900
Council Creek			500
Deer Creek			900
Dixon Creek			500
Dodgeville Creek			400
Dustin Creek			400
Jenning's creek			500
La Crosse River			500
La Fleur Creek			500
Little Lemonweir River			400
Little Silver Creek			400
Mill Creek			1,000
Mud Creek			500
Pine Creek			500
Prairie Creek			500
Robinson Creek			500
Rudd's creek			500
Sand Creek			500
Saw Creek			500
Silver Creek			500
Soney Creek			500
Sparta Creek			900
Squaw Creek			500
Tomahawk, Armstrong Creek			100
Avril Creek			100
Berry Creek			100
Big Pine Creek			100
Crocker's creek			100
Forest Creek			500
Hay Creek			100
Kuehling's run			100
Little Rice Creek, North Branch			100
Little Rice Creek, South Branch			100
Little Somo River			100
Lonely Creek			100
Manson Creek			100
New Wood Creek, North Branch			100
New Wood Creek, West Branch			100
Noisy Creek			500
Pine Creek, South Branch			100
Prairie River, North Branch			100
Rocky Run			100
Skanawan Creek			100
Somo River, Middle Branch			100
Somo River, North Branch			100
Somo River, South Branch			100
Spring Creek			100
Squaw Creek			100
Trout Creek			100
Willow Creek			100
Viroqua, Beabout Creek			1,400
Bishop Branch			1,400
Brookville Creek			1,400
Brown's branch			1,400
Brush Hollow Creek			1,400
Carey's creek			2,400
Cedar Branch			1,400
Cheatham Branch			1,400
Cook Branch			1,400
Coon Creek, Timber Coulee Fork			400
Conaway Creek			1,400
Elk Run			1,400
Getters Creek			1,400
Harrison Branch, North Folk			2,400
Harrison Branch, South Fork			1,100

DISTRIBUTION OF FISH AND FISH EGGS, BY LOCALITY AND SPECIES, FISCAL YEAR 1913—Continued.

BROOK TROUT—Continued.

Disposition.	Eggs.	Fry.	Fingerlings, yearlings, and adults.
Wisconsin—Continued.			
Viroqua, Lee's branch			2,000
Pine Hollow Creek			1,400
Purdy Branch			1,400
Rogers Creek			2,400
Sees Branch			400
Sidie Branch			2,400
Spring Lake			400
Springville Branch			2,400
Wascott, Bergen Creek			22,000
Westby, Beard Branch			400
Clockmaker Run			400
Coon River, East Branch			400
Coon Creek, South Branch			4,000
Hanson Spring Brook			400
Jefson Spring Run			400
Kickapoo Branch			2,000
Knapp Run			400
Morterud Run			400
Rogstad Branch			400
Rulland Creek			400
Sanding Creek			2,000
Sease Branch			400
Sending Spring Run			400
Sloan Creek			400
Springdale Run			400
Spring Valley Creek			4,400
Swenson Branch			400
Timber Coulee Creek			400
Tveidt Run			400
Wheeler, Big Beaver Creek			1,000
Big Otter Creek			3,000
Blank's creek			1,000
Lamb's creek			1,000
Little Beaver Creek			1,000
Little Otter Creek			1,000
Messenger Creek			1,000
Phoebe Creek			1,000
Sink Creek			1,000
Wilton, Beechers Creek			400
Billings Creek			400
Cold Spring Creek			400
Dorset Creek			400
Hibbards Creek			400
Indian Creek			400
Kickapoo River			400
Sinks Creek			400
Slaten Creek			400
Summerfeldt Creek			400
Thurows Creek			400
Winneboujou, Brule River			8,000
Cutlers Creek			4,000
Little Brule River			6,000
Long Lake			6,000
Lucius Lake			4,000
Nebagamon River			6,000
Woodruff, Squirrel Creek			160
Wyoming:			
Basin, Paint Rock Creek			420
Ten Sleep Creek, East and West Forks			420
Beulah, Red Cannon Creek			2,500
Sand Creek			27,500
Cody, Bobcat Creek			280
Boulder Creek			280
Clearwater Creek			280
Crandall Creek			280
Dick Creek			280
Fish Hawk Creek			280
Frances Fork Creek			280
Gunbarrel Creek			280
Gunnell Creek			280
Ishawooa Creek			280
Jones Creek			280
Middle Creek			280
Shoshone River, North Fork			280

DISTRIBUTION OF FISH AND FISH EGGS, BY LOCALITY AND SPECIES, FISCAL YEAR 1913—Continued.

BROOK TROUT—Continued.

Disposition.	Eggs.	Fry.	Fingerlings, yearlings, and adults.
Wyoming—Continued.			
Cody, Shoshone River, South Fork			700
Spring Creek			280
Sunlight Creek			280
Sweetwater Creek			280
Timber Creek			280
Wood River, Middle Fork			280
Wood River, North Fork			280
Wood River, South Fork			280
Laramie, applicant	50,000		
State fish commission	100,000		
Manchester, Soldier Creek			20,000
Tongue River			2,100
Sheridan, Little Goose Creek			560
State fish commission	75,000		
Wolf, Decker's pond			1,050
Yellowstone Park, Blacktail Creek			22,500
Canada:			
Southampton, Canadian Government	150,000		
Total [a]	1,239,000	5,280,452	6,014,645

[a] Lost in transit, 19,436 fry and 17,170 fingerlings.

GRAYLING.

Disposition.	Eggs.	Fry.
California:		
Sisson, State fish commission	50,000	
Michigan:		
Paris, State fish commission	50,000	
Montana:		
Anaconda, State fish commission	588,000	
Bozeman, Red Rock Lake		573,000
Butte, applicant	100,000	
Ennis, Madison River		640,000
Harlowton, Musselshell River		39,000
Norris, Bear Creek		50,000
Cedar Creek		50,000
Jack Creek		100,000
North Meadow Creek		115,000
Odell Creek		130,000
South Meadow Creek		170,000
Red Rock, Red Rock Lake		655,000
Twodot, Big Elk Creek		26,000
West Gallatin, West Gallatin Creek		65,000
New York:		
New Milford, applicant	15,000	
Wyoming:		
Laramie, applicant	50,000	
Story, State fish commission	50,000	
Total	903,000	2,613,000

CRAPPIE AND STRAWBERRY BASS.

Disposition.	Fingerlings.	Disposition.	Fingerlings.
Arkansas:		Arkansas—Continued.	
Abbott, Little's pond	80	Mammoth Spring, Martins Creek	120
Conway, McCulloch & Allinder's pond	80	Spring River	300
Danville, Clear Lake	80	Marked Tree, St. Francis River	1,779
El Dorado, Lake Eagle	80	Russellville, Illinois River	120
Heber Springs, Little Red River	80	Texarkana, Twin Ponds	70
Hope, Pleasure Lake	350	Van Buren, Lee's creek	80

DISTRIBUTION OF FISH AND FISH EGGS, BY LOCALITY AND SPECIES, FISCAL YEAR 1913—Continued.

CRAPPIE AND STRAWBERRY BASS—Continued.

Disposition.	Fingerlings.
Connecticut:	
Danbury, Keystone Lake	200
Delaware:	
Wilmington, Brandywine Creek	500
Delaware River	500
Georgia:	
Sulphur Springs, Little River	135
Illinois:	
Belleville, Four Mile Lake	200
Casey, Weaver's pond	200
Cherry Point, Grove Pond	100
Chicago, Barrington Ponds	150
Clinton, Weldon Springs Lake	300
Coulterville, Illinois Central Railroad Lake	200
Decatur, Decatur Club Lake	2,450
Effingham, Grenel's pond	100
Hinsdale, Salt Creek	500
Honey Bend, Crawford Ponds	100
Jacksonville, Nichols Park Lake	200
La Harpe, Prairie Pond	200
Litchfield, Chatauqua Lake	300
Marshall, Chrystal Lake	300
Martinsville, Buckle Pond	200
Mascoutah, Schroeder's pond	200
Meredosia, Illinois River	150
Mississippi River	100
Millstadt, Bluffside Lake	200
Mitchell, Long Lake	750
Momence, Kankakee River	400
Oakland, Embarras River	400
Rockefeller, Lake Era	300
Shipman, Clarks Lake	200
Sigel, Sonne's pond	100
Watseka, Iroquois River	400
Iowa:	
Anamosa, Buffalo River	400
Ayrshire, Silver Lake	500
Bellevue, Mississippi River	7,800
Casey, Skellenger's pond	100
Chester, Upper Iowa River	800
Clarion, Elm Lake	400
Dyersville, Maquoketa River	400
Eldora, Iowa River	800
Fort Atkinson, Turkey River	400
Harlan, Willow Shade Pond	100
Hazleton, Otter Creek	500
Sewal, Collins Pond	700
Worthington, Maquoketa River	400
Kansas:	
Alma, Mill Creek	300
Attica, Campbell's pond	100
Edna, Kendalls Elm Lake	100
Fort Scott, Marmaton River	300
Mill Creek	300
Paint Creek	300
Fredonia, Coleman Pond	100
Frater Lake	200
Pierce's lake	150
Frontenac, Fishing Club Ponds	400
Jones's pond	100
Harper, Island Pond	100
Huron, Anthony's pond	900
Kling, Cement Company Lake	300
Medicine Lodge, Best's pond	300
Ellis Lake	100
Neutral, Ransom's lake No. 2	200
Tyro, Tyro Lake	200
Vermillion, Midland Pond	100
Kentucky:	
Bowling Green, Doore's pond	100
Clinton, Sunset Pond	100
Danville, Cecils Pond	100
Dix River	200
Fidelio, Cherry's pond	100
Kentucky—Continued.	
Fredonia, Brasher's pond	100
Garner Lake	100
Mun's pond	100
Slick Bank Pond	100
Greenbrier, Lake Greenbrier	200
Greenville, Finley's pond	100
Guthrie, Northington's pond	100
Harrodsburg, Spring Lake	100
Hempridge, Sessee's pond	100
High Bridge, Dorman's pond	100
Howell, King Pond	100
Wilson's pond	100
La Center, Baker's pond	200
Lawrenceburg, Lake Geronimo	200
Marrs Lake	100
Lexington, Belmont Pond	400
Louisville, Cardinal Hill Pond	100
Deer Lick Pond	100
Harris Lake	100
Klondyke Pond	100
Lake Lansdowne	400
Liter's pond	100
Ohio River	6,200
Shadyside Lake	200
Wagner's pond	100
Middlesborough, Fern Lake	725
Nicholasville, Bryant's pond	100
Farra's pond	100
Simpson Lake	100
Paducah, Goodman's pond	100
Russellville, Browning Pond	100
Noe Pond	100
Orange Pond	100
Wild Goose Pond	100
Shelby City, Smith's pond	100
Shelbyville, Hall's lake	200
Lake Jonorockqua	200
Snook Pond	100
Stanley Lake	100
Stanley's pond	100
Spring Station, Blackburn's pond	600
Canewood Pond	100
Stanford, Bright's pond	75
Fish's pond	100
Sturgis, Willingham's pond	100
Wilmore, Lowry Pond	100
Maryland:	
Landover, Indian Pond	150
Washington Junction, Doubs Creek	200
Massachusetts:	
Plymouth, South Triangle Pond	400
Michigan:	
Bellaire, Intermediate Lake	200
Clyde, Pettibone Lake	100
Spring Lake	100
White Lake	150
Doster, Pine Lake	150
Grand Rapids, Grand River	100
Indian River, Indian River	150
Rose Center, Green Lake	100
North Buckhorn Lake	150
Minnesota:	
Hokah, Pettibone Park Lake	300
Lanesboro, Root River	200
Root River, branch of	200
Root River, North Branch	200
Root River, South Branch	200
Le Roy, Little Iowa River	200
Mill Pond	100
Preston, Root River, North Branch	200
RootRiver, South Branch	200
Rochester, Zumbro River, South Branch	200
Rushford, Root River	200

DISTRIBUTION OF FISH AND FISH EGGS, BY LOCALITY AND SPECIES, FISCAL YEAR 1913—Continued.

CRAPPIE AND STRAWBERRY BASS—Continued.

Disposition.	Fingerlings.
Minnesota—Continued.	
Spring Valley, Deer Creek	200
Taylors Falls, St. Croix River	400
Mississippi:	
Centerville, Anderson's pond	60
Ingleside Pond	100
Lake View	100
Columbus, Tombigbee River	400
Edwards, Kids Lake	200
King Lake	100
Whites Mill Pond	25
Gloster, Fern Lake	30
Jackson's pond	30
Ratcliff Creek	60
Hickory, Caraway's pond	100
Jackson, Fair Ground Pond	200
Manhattan Pond	200
Round Hole Lake	325
Learned, Clear Lake	60
Martin, Placid Pond	60
Shannon, Crubaugh's pond	100
Smith Station, Gibbs Lake	200
Ginn Lake	50
Montgomery's pond	50
Stallo, Jackson's pond	500
Utica, Carmichael's pond	60
Vicksburg, Long Lake	300
West Point, Malone's pond	100
Missouri:	
Blackburn, Blackburn Pond	200
Bridgeton, Edrus Lake	500
Centralia, Lake Dutcher	200
Chilhowie, Osborn's pond	100
Clayton, Wolff's lake	100
Clinton, Fish Lake	300
Drexel, Silver Lake	100
Silver Pond	100
Firma, Piscatorial Lake	300
Huntsville, Clear Ridge Pond	100
Rutherford's pond	100
Kansas City, Fairmount Lake	300
Witte's lake	200
Witte's pond	200
Lebanon, Mayfield's pond	100
Liberty, Petty's lake	100
Marshall, Lake Saline	200
Marceline, Marceline City Reservoir	200
Santa Fe Reservoir	200
Medford, Medford Reservoir	300
Oak Grove, Deep Water Pond	100
Mill Pond	100
Parkville, Emily Heights Pond	100
Pendleton, Lake Farm Pond	600
Pierce City, Saulsbury's pond	100
St. James, Dellacella Ponds	300
St. Joseph, Missouri River	150
South Greenfield, Dicus Pond	100
Montana:	
Kalispell, Emmert Lake	160
New York:	
Chatham, Kinderbrook Creek	100
Ithaca, Experimental Ponds	200
Gloversville, East Garoga Lake	300
West Garoga Lake	300
Petersburg, Taconee Lake	400
Ohio:	
Chippewa Lake, Chippewa Lake	200
Dunkirk, Groat's pond	100
Fredericksburg, Salt Creek	100
Lima, Lake Picquita	100
Perry, Brown's pond	100
Ravenna, Crystal Lake	200
Salem, Salem Country Club Pond	300
Wharton, Wise Pond	100
Oklahoma:	
Ardmore, Chickasaw Lake	1,000
McCullom's lake	100
Pats Lake	200
Oklahoma—Continued.	
Elgin, Shirk's pond	100
Willow Pond	100
Guthrie, Overtons Lake	200
Reddingtons Lake	200
Twin Lakes	200
Walkers Lake	200
Lawton, Chandler Creek	300
Durbar Pond	100
Indian Creek	100
Lake Gondola	200
Little Medicine Creek	200
Medicine Creek	200
Medicine Lake	200
Medicine Park Lake	200
Shirk's pond	100
Simpson's pond	200
Spencer Creek	100
McAlester, McAlester Country Club Lake	300
Marietta, Blake Lake	100
Campbell's pond	100
Grassey Pond	100
High Lake	100
Hovenkamp Lake	200
McKinney Lake	100
Marietta Lake	100
Piland's pond	100
Mustang, Henry's lake	100
Noble, Montgomery Lake	100
Purcell, Black Jack Pond	200
Conkling's pond	100
Shawnee, Lomey's pond	200
Waterloo, Schwake's pond	100
Oregon:	
Carlton, Carlton Lake	180
Pennsylvania:	
Hamburg, Schmick's pond	100
Mohrsville, Beckers Mill Pond	100
Philadelphia, Fairmount Park Aquarium	130
Ryde, Juniata River	400
South Dakota:	
Ardmore, Pease Lake	200
Murdo, Railroad Pond	100
Philip, Grindstone Creek	100
Plankinton, Fish Lake	300
Pukwana, Millage's pond	100
Tennessee:	
Hampton, Biggars Pond	100
Cakes Pond	300
Henning, Rice's pond	80
Norma, Lake Christine	1,400
Texas:	
Dallas, Weichsell's pond	50
Greenville, Compress Pond	25
McCombs Lake	25
Wise's pond	25
Livingston, Israel Pond	25
New Braunfels, Comal Creek	100
Comal River	100
San Antonio, Elmendorf Lake	35
San Marcos, San Marcos River	150
Tenaha, Oxner Lake	25
Waxahachie, Brown's pond	25
Spalding Lake	25
Vermont:	
Ludlow, Lake Okemo	200
Virginia:	
Beaver Dam, Little River	500
Thompson's pond	100
Ellerson, Rutland Club Lake	200
Emporia, Mill Pond	350
Leesburg, Lime Kiln Pond	100
Manchester, Collom Pond	200
Selden's pond	200
Petersburg, Spicers Pond	200
Richmond, Darbytown Pond	200

DISTRIBUTION OF FISH AND FISH EGGS, BY LOCALITY AND SPECIES, FISCAL YEAR 1913—Continued.

CRAPPIE AND STRAWBERRY BASS—Continued.

Disposition.	Fingerlings.
Virginia—Continued.	
Richmond, Ellerslie Pond	100
Gerheart Pond	200
Glendale Pond	200
Hopewell Pond	200
Johnson's pond	200
Joseph Bryan Pond	200
Licking Creek Club Pond	200
Powells Pond	400
Providence Forge Pond	100
Water View Mill Pond	100
Westham Club Pond	200
Yaley's pond	200
Washington:	
Moab, Newman Lake	200
Spokane, Clear Lake	200
Tacoma, American Lake	90
Tacoma, Balches Lake	90
Church Lake	90
Gravelly Lake	90
Kreger Lake	90
Osting Lake	90
Rapjohn Lake	90
Spanaway Lake	90
Steilacoom Lake	90
West Virginia:	
Shepherdstown, Potomac River	1,345
Wisconsin:	
Mercer, Trude Lake	500
Wyoming:	
Shoshoni, Power Pond	300
Total [a]	79,279

ROCK BASS.

Alabama:	
Altoona, Durham Spring Pond	100
Bessemer, Veitch's lake	100
Erin, Ramsey's pond	100
Girard, McMurrain's pond	150
Midland City, Byrd Pond	150
Montgomery, Crescent Lake	500
Oneonta, Sand Lake	200
Russellville, Devany Pond	150
Arkansas:	
Alexander, Blevins's pond	250
Elkins, Mountain Brook Lake	400
Hackett, Forbes's pond	400
Hoxie, Phoenix Cotton Oil Co.'s pond	250
Georgia:	
Adel, Hutchison's pond	100
Atlanta, Whiteman's pond	75
Blue Ridge, Anderson's pond	75
Bronwood, Horseshoe Lake	300
Crawfordville, Chapman's pond	75
Dawson, Baldwin's pond	150
Fairburn, Brantley's pond	150
Brassell's pond	100
Hill City, Copeland's pond	150
Madison, Poplar Pond	75
Norristown, Mule Pen Pond	350
Rome, Simpson's pond	100
Roswell, Bowen's lake	150
Lummus's pond	150
Ocmulgee Lake	150
Rutledge, Estes Pond	75
Stone Mountain, Venable Lake	150
Tate, Creole Quarry Pond	75
Etowah Quarry Pond	75
Valdosta, Fly Pond	100
Illinois:	
Belleville, Fern Glen Lake	300
Heinemann Lake	400
Decatur, Decatur Club Lake	1,750
Edwardsville, Oak Hill Pond	100
Peoria, Exposition Park Lake	200
Shipman, Olmsted's pond	100
Toulon, Craig's pond	100
Indiana:	
Bloomfield, Emery's pond	150
Brazil, Macbeth's pond	100
Chandler, Locust Pond	150
Ferdinand, Muller's pond	100
Morris, Merkel's pond	150
Osgood, Hallgarth's pond	100
Rushville, Green's pond	150
Iowa:	
Chester, Upper Iowa River	225
Malvern, Craig's pond	200
Kansas:	
Lillis, Midland Pond	400
Kentucky:	
Banklick, William's pond	100
Chilesburg, Crimms Quarry Pond	150
Franklin, Roark's pond	100
Steward's pond	100
Guthrie, Hibiscus Lake	200
Hodgenville, Ford's pond	100
Stark's pond	200
Hyattsville, Hurt's pond	100
La Grange, Morgan's pond	100
Lebanon, Jackson's pond	100
Middlesborough, Fern Lake	200
Mount Sterling, Cooper's pond	100
Munfordville, Chapman's pond	100
Shelbyville, Watkins Pond	100
Stanford, Shanks's pond	100
Louisiana:	
Shreveport, Big Lake	100
Maryland:	
Cropley, Potomac River	200
Ellicott City, Powell's pond	230
Long Green Station, Quarry Pond	100
Rogers, Robinson's pond	230
Massachusetts:	
Hingham, Foley's pond	100
Norfolk, Hillside Pond	100
Minnesota:	
Rochester, Zumbro Mill Pond	250
Mississippi:	
Amory, Pride Pond	100
Booneville, Mason's lake	175
Brooksville, Hendrix Pond	100
Edwards, Marsh's pond	150
Gloster, Berryhill's pond	150
Jackson, Raines's pond	225
Simmon's pond	225
Learned, Haman's pond	150
McComb, Illinois Central Reservoir	150
Natchez, Mount Airy Pond	150
New Albany, Thompson's pond	150
Ripley, Nance's pond	300
Starkville, Cunningham's pond	150
Waynesboro, Pattons Creek	100
West Point, Hamlin's ponds	200
Missouri:	
Bunceton, Doublin Branch	300
Coal Bank Creek	300
Stephens Branch	300
Cabool, Coyle Lake	300
Crane, Crane Creek	400
Independence, Rose Hill Lake	100
Whites Lake	400

[a] Lost in transit, 3,180.

DISTRIBUTION OF FISH AND FISH EGGS, BY LOCALITY AND SPECIES, FISCAL YEAR 1913—Continued.

ROCK BASS—Continued.

Disposition.	Fingerlings.
Missouri—Continued.	
Marshall, Hennesy Lake	400
Nadja, Spring Lake	200
Neosho, Hickory Creek	1,598
Nevada, State Hospital Lake	300
Oak Grove, Bluewater Pond	400
Osborn, McQuate's pond	300
Pearl, Shady Brook Pond	150
Rolla, Big Beaver Creek	800
Big Dry Fork Creek	400
Kentuck Creek	600
Lake Frisco	450
Little Beaver Creek	400
Little Piney Creek	400
North Mill Creek	450
Renix Lake	300
Springfield, Tawasentha Lake	400
New York:	
Middletown, Wallkill River	350
Whitestone, Fort Totten Pond	350
North Carolina:	
Candor, Clark's pond	150
Catawba, Bridge's pond	200
Davidson, Linden Pond	100
Durham, Chemical Company Pond	100
Eno River	800
Goldsboro, Foldsame Pond	200
Kinston, Marston's pond	300
Matthews, Lilly's pond	100
Ohio:	
Batavia, Nepper's pond	150
Blue Ash, Cliff Farm Lake	150
Chippewa Lake, Chippewa Lake	400
Congress Lake, Congress Lake	500
Springfield, Red Bud Lake	100
Williamsburg, Deeny's pond	100
Oklahoma:	
Ardmore, Cruce Lake	300
Dings Lake	300
Fairview Lake	200
Maxwell's pond	100
Potter Lake	300
Enid, Matthews's pond	100
Spring Creek	200
Mangum, Cowan's pond	100
Milburn, Smedley's pond	100
Young's pond	100
Morrison, Turner's pond	100
Stillwell, English's pond	100
Shawnee, Maud Lake	300
Tulsa, Frye's pond	100
Warner, Switzer's pond	100
Pennsylvania:	
Chester, Ridley Creek	400
Lebanon, Conewago Lake	300
Water House Lake	300
Lehighton, Parryville Pond	230
Pottsville, Rilands Pond	230
Rhode Island:	
Slocum, Gray's pond	100
South Carolina:	
Catawba, Lesslie's pond	200
Donalds, Cedar Pond	200
White Oak Pond	400
Newberry, Digby's pond	100
Lawrens, Bolt Branch	400
Rock Hill, Crockett Farm Pond	300
Massey's pond	300
Spartanburg, Moss Springs Pond	100
Walhalla, Devil's Fork Creek	200
Oconee Creek	200
Tennessee:	
Chattanooga, Lake Lookout	225
Niota, Schumann's pond	75
Texas:	
Belcherville, Benton Pond	60
Bering, Valda Lake	75
Burton, Eberhardt's pond	50
Mayfield Pond	50
Texas—Continued.	
Carmine, Nagel's pond	50
Crystal City, Coleman's pond	75
Popper's pond	75
Denison, Duck Creek	50
Paw Paw Creek	50
Shawnee Lake	100
Eddy, Bridgewater's pond	50
Wilkinson's lake	50
Elgin, Christian's lake	50
Thomas's pond	50
Fate, McLendon's pond	50
Fort Worth, Duringer Lake	125
Frankston, De Long Lake	100
Giddings, Boettcher Lake	50
Kluge's pond	50
Gilmer, Highland Pond	175
Reynold's pond	175
Holland, Houston's pond	50
Reed's pond	50
Houston, Bering's pond	75
Joaquin, Blackmon's pond	75
Marion, Ebert's pond	50
New Braunfels, Comal River	200
Paige, Sunny Slope Pond	50
Purdon, Peden's pond	40
San Antonio, Dullnig's lakes	150
Reichert's pond	100
Spofford, Stratton's pond	100
Terrell, Ables Pond	100
Britton's pond	100
Childress Pond	100
Cook's pond	100
Dennis Pond	100
Edwards's pond	100
Elliott's pond	100
Evans Lake	100
Fleetwood's pond	100
Flowers Pond	100
Garland Pond	100
Harmon Pond	100
Henderson Pond	100
Hopkins Pond	100
Johnson Pond	100
McClung's pond	100
Martin's pond	100
Moore Pond	100
Muckleroy's lake	100
Mullins Pond	100
Roberts Lake	100
Sandford's pond	100
Stallings's pond, No. 1	100
Stallings's pond, No. 2	100
Stoys Pond	100
Waters Pond	100
Virginia:	
Bedford City, McGhee's pond	100
Bridgewater, Crystal Lake	500
Burnt Chimney, Cox's pond	100
Charlottesville, Rappahannock River	300
Danville, Haymore Pond	100
Hill's pond	100
Merriewold Lake	400
Dillwyn, Rolfton Pond	300
East Radford, Sale's pond	100
Evington, Davis's pond	100
Ould's pond	300
Glasgow, Moose Pond	200
Lanexa, Woodward's pond	200
Lynchburg, Carroll's pond	200
Mineral, Loving's pond	300
Palmyra, Cunningham Creek	500
Paynes Siding, Isaac Walton Pond	400
Philpott, De Hart's pond	100
Hartville Pond	100
Providence Forge, Providence Forge Pond	500
Remington, Rose Dale Pond	200

Distribution of Fish and Fish Eggs, by Locality and Species, Fiscal Year 1913—Continued.

ROCK BASS—Continued.

Disposition.	Fingerlings.
Virginia—Continued.	
Richmond, Youngs Pond	500
Ringgold, McLaughlin's pond	430
Rock Castle, Finch's pond	500
Roxbury, Cosby Mill Pond	500
Salem, Roanoke River	500
Scottsville, Chester Pond, No. 1	300
Chester Pond, No. 2	300
Smithfield, Porter's pond	400
Somerset, Yager pond	300
State Farm, State Farm Pond	300
Stuart, Mayo River	250
Thaxton, Sublett's pond	100
Tunstall, Hampstead Pond	400
Walkers, Christian's pond	500
Vaidens Pond	1,000
Virginia—Continued.	
Warren, Black Rock Pond	200
Windsor, Porters's pond	400
Wytheville, Baumgardner's pond	300
Washington:	
Tacoma, American Lake	300
Gravelly Lake	300
Steilacoom Lake	200
West Virginia:	
Cabwell, [illegible]	[illegible]
Mullens, Barkers Creek	100
Shepherdstown, Potomac River	7,000
Woodlands, Meadowdale Pond	200
Yoho's pond	200
Total [a]	64,743

WARMOUTH BASS.

Disposition.	Fingerlings.
Maryland:	
Great Falls, Potomac River	1,115
Georgia:	
Norcross, Lake Hoyle	125
Mississippi:	
Yazoo City, Ewing Pond	150
Total	1,390

SMALL-MOUTH BLACK BASS.

Disposition.	Fry.	Fingerlings.
Arkansas:		
Mammoth Spring, Spring River		8
Many Islands, Spring River		95
St. Francis, St. Francis River		1,350
Sylamore, North Sylamore Creek		180
South Sylamore Creek		180
Colorado:		
Arboles, Piedra River		300
Littleton, South Platte River		200
Connecticut:		
Norwich, Gardner Lake		120
State Line, Forest Lake		200
Delaware:		
Harrington, Smith's pond		120
Seaford, Williams Pond		120
Townsend, Noxentown Pond		120
Florida:		
Tavares, Lake Tavares		400
Georgia:		
Atlanta, aquarium, State Capitol		12
Concord, Evergreen Pond		650
Lake Park, White Water Club Pond		400
Idaho:		
Hauser, Mud Lake		100
Illinois:		
Anna, Kohler Pond		250
Barstow, Rock River		2,000
Dixon, Rock River		300
Lake Villa, Douglas Lake		225
Indiana:		
Anderson, Fall Creek		600
Killbuck Creek		400
White River		600
Indiana—Continued.		
Brooklyn, White Lick Creek		500
Columbia City, Cedar Lake		600
Round Lake		600
Tippecanoe Lake		600
Corydon, Indian Creek		150
Culver, Lake Maxinkuckee		1,000
Dupont, Guthries Park Pond		500
Indianapolis, Buck Creek		1,000
Eagle Creek		1,250
Sugar Creek		1,250
White River		1,000
North Vernon, Otter Creek		250
Vincennes, Frisz Lake		150
Iowa:		
Chester, Upper Iowa River		225
Decorah, Iowa River		2,000
Mason City, Lime Creek		1,500
New London, Sunapee Lake		200
Riceville, Little Cedar River		100
Kansas:		
Garnett, Cedar Creek		250
Kentucky:		
Auburn, Clear Fork Creek		600
Bowling Green, Drakes Creek		1,400
Barren River		1,400
Buchanan, Big Sandy River	15,000	
Cadiz, Donaldson Creek		900
Central City, Martwick Pond		600
Clermont, Echo Lake		1,400
Crab Orchard, Dix River	5,000	
Danville, Dix River	20,000	
Frankfort, Elkhorn River	15,000	
Hopkinsville, Little River		2,200
Little River, Sinking Fork		1,400
Hyattsville, Hiatt's pond	5,000	

[a] Lost in transit, 450.

DISTRIBUTION OF FISH AND FISH EGGS, BY LOCALITY AND SPECIES, FISCAL YEAR 1913—Continued.

SMALL-MOUTH BLACK BASS—Continued.

Disposition.	Fry.	Fingerlings.
Kentucky—Continued.		
Lancaster, Hanging Fork River	15,000	
Lebanon, Office Pond		1,400
Salt River, Rolling Fork		1,400
Maine:		
Ayers Junction, Meddybemps Lake	1,200	
Oakland, Little Pond	1,200	
Sherman Station, Salmon Stream Lake	1,200	
Maryland:		
Baltimore, Magothy River		120
Cropley, Potomac River		120
Detour, Double Pipe Creek		60
Eccleston, The Caves Pond		60
Great Falls, Potomac River		3,640
Hagerstown, Antietam River	15,000	
Jones Station, Park Lake	6,000	
Timonium, Price's lake		60
Westminster, Myers Lake	5,000	
Massachusetts:		
Ashburnham, Vankeag Lake	1,200	
Charlton Depot, Williams Meadow Pond	800	
Congamond, Congamond Lake		100
Ipswich, Symond's pond	800	
Lee, Greenwater Lake	1,200	
Stockbridge Lake	1,200	
Lynn, Upper Pond	400	
Orleans, Bucks Pond	1,200	
Palmer, State fish commission	1,200	
Webster, Webster Lake	1,200	
Peter Pond	800	
West Barnstable, Joshua Pond		100
Williamsburg, Highland Lake	1,000	
Michigan:		
Athens, Nottawa River		800
Baldwin, Little Star Lake		800
Bellaire, Grass Lake		600
Calumet, Beaver Lake		162
Breakfast Lake		324
Deer Lake		324
Central Lake, Intermediate Lake		600
Clarkston, Deer Lake		800
Davisburg, Big Lake		800
Drayton Plains, Loon Lake		800
Eagle Harbor, Duncans Bay		170
East Tawas, Bass Lake		2,000
Ellsworth, Chain of Lakes		600
Fenton, Donavan Lake		800
Haslett, Pine Lake		800
Holly, Bush Lake		800
Humboldt, Flat Lake		162
Silver Lake		162
Ishpeming, Flat Lake		400
Lakeland, Zuke Lake		2,000
Lake Station, Crooked Lake		600
Linden, Days Lake		800
Milford, Steeple Hill Lake		1,000
Muskegon, Wolf Lake		800
Otsego Lake, Otsego Lake		3,000
Palatka, Chicagon Lake		160
Spring Lake, Spring Lake		2,000
Turtle, Bear Lake		600
Clearwater Lake		400
Hawk Lake		600
Independence Lake		600
Little African Lake		400
Ormes Lake		600
Rowe Lake		400
Vicksburg, Thurgirls Lake		800
Watersmeet, Allen Lake		560
Bass Lake		400
Beaver Lake		560
Darling Lake		160
Michigan—Continued.		
Watersmeet, Duck Lake		760
East Bear Lake		760
Lake Marion		560
Lake Mary		160
Reef Lake		400
Round Lake		560
Wolf Lake		400
Wingleton, Hammond Lake		800
Minnesota:		
Duluth, Evens Lake		340
Ely, Burntside River		340
Le Roy, Minnesota River		180
Wildwood Pond		180
Ogema, White Earth Lake		360
Osakis, Osakis Lake		360
St. Peter, Lake Emily		100
Lake Jefferson		100
Lake Washington		100
Spring Valley, Spring Creek		225
Taylors Falls, St. Croix River		360
Watab, Little Rock Lakes		360
Nebraska:		
Gordon, Clear Lake		200
Horseshoe Lake		275
New Hampshire:		
Antrim, Gregg Pond	1,200	
Wildwood Pond	400	
Berlin, Head Pond	800	
Canaan, Crystal Lake	1,200	
Milford, Baboosic Lake	1,200	
Pittsfield, Jenness Pond	800	
Plaistow, Angle Pond	800	
Walpole, Connecticut River	800	
New York:		
Clayton, St. Lawrence River		5,800
La Grange, Ikes Pond		200
Monroe, Mountain View Lake		100
Roscoe, Lakewood Lake		100
Walden, Wallkill River		300
West Pawling, Whaley Pond		100
North Carolina:		
Gela, Lake Caldwell		585
Liberty, Coxe's pond		290
Ohio:		
Akron, Cuyahoga River		300
Dayton, Patterson's pond		75
Tiffin, Sandusky River		300
Oregon:		
Carlton, Carlton Lake		100
Pennsylvania:		
Greensburg, Keystone Lake		200
Lancaster, Conestoga River		200
Peach Bottom, Susquehanna River		240
Philadelphia, Darby Creek and tributaries		200
Tionesta, Allegheny River		280
Tennessee:		
Perryville, Buffalo River		75
Utah:		
Provo, Utah Lake		160
Vermont:		
Brandon, Lake Hortonia	6,000	
Cambridge, Half Moon Pond	1,500	
Medcalf Pond	1,500	
Concord, Hall's pond		200
Danville, Mud Pond	2,000	
Enosburg, Lake Carmi	2,000	
Fletcher, Metcalf Pond		200
Groton Pond, Groton Lake	2,000	
Hardwick, Valley Lake	2,000	
Jamaica, Adams Pond		400
Johnson, Lamoille River	2,000	
Lyndonville, Center Pond	4,000	
Middlebury, Otter Creek	9,000	
Miles Pond, Miles Pond		300

Distribution of Fish and Fish Eggs, by Locality and Species, Fiscal Year 1913—Continued.

SMALL-MOUTH BLACK BASS—Continued.

Disposition.	Fry.	Fingerlings.
Vermont—Continued.		
Morrisville, Big Pond	1,000	
Collins Pond	2,000	
Lake Lamoille	2,000	
Proctor, Burr Pond	1,500	
Rutland, Burr Pond	1,500	
East Pittsford Pond	1,500	
Meadow Lake	2,000	
South Ryegate, Halls Pond	1,500	
Round Pond	1,500	200
Walden, Cole's pond	2,000	
Swanton, Lake Champlain		600
West Danville, Joe's pond		200
Wolcott, Wolcott Pond		200
Virginia:		
Ashby Station, Shenandoah River	15,000	
Fredericksburg, Rappahannock River		200
Great Falls, Potomac River		239
Salem, Roanoke River		200
Washington:		
Calvert, Buckeye Lake		100
Calvert Lake		100
Loon Lake, Loon Lake		200
West Virginia:		
Capon Springs, Cacapon River	18,000	
Keyser, Pattersons Creek		216
Martinsburg, Back Creek		200
Opequon Creek		200
Potomac River		324
Renick, Greenbrier River	10,000	
Romney, Potomac River, South Branch		200
Wellsburg, Buffalo Creek	10,000	
Cross Creek	10,000	
Wheeling, State Fair Aquarium		17
Wisconsin:		
Amery, Clare Lake		360
Round Lake		360
Armstrong Creek, Lake Gordon		324
Lake Hilbert		324
Lake Laura		324
Baldwin, Balsam Lake		360
Cable, Wiley Lake		360
Chetek, Bass Lake		360
Centuria, Balsam Lake		540
Donaldson, Donahue Lake		320
Wisconsin—Continued.		
Donaldson, Goose Lake		320
Little Bass Lake		150
Moon Lake		395
Sand Lake		150
Spring Lake		320
Dunbar, Coleman Lake		324
Moon Lake		274
Elcho, Bass Lake		340
Enterprise Lake		415
Otter Lake		340
Pine Lake		340
Fond du Lac, Lake de Neveu		1,450
Hayward, Bass Lake		1,080
Hurley, Price Lake		75
Iron River, Crooked Lake		340
Pike Lake		340
La Crosse, French Creek		100
Gibbs Chute Creek		100
Hammond Chute Creek		100
Running Creek		100
Shingle Creek		100
Smith Creek		100
Manitowoc, Pigeon Lake		480
Mercer, Trude Lake		300
Mosinee, Half Moon Lake		75
Lake Mosinee		75
Wisconsin River		75
Nashville, Crystal Lake		340
Horseshoe Lake		170
Little Sand Lake		170
Mole Lake		340
Pickerel Lake		340
Nye, Big Lake		360
Church Pine Lake		360
Lake Nakomis		360
Round Lake		360
Pelican, Pelican Lake		75
Superior, Amnicon Lake		510
Three Lakes, Planting Ground Lake		75
Vudesare, Birch Lake		320
Pine Lake		320
Wild Rose, Silver Lake		320
Williams Bay, Lake Geneva		2,000
Total	234,300	107,641

LARGE-MOUTH BLACK BASS.

Disposition.	Fry.	Fingerlings, yearlings, and adults.
Alabama:		
Alton, Queenstown Lake		300
Anniston, Cane Creek		300
Choccolocco Creek		300
Chulafinnee Creek		200
Hillaby Creeks		100
Oxford Lake		300
Rock Creek		100
Young's pond		200
Bell Factory, Flint River		1,000
Belle Mina, Beaver Dam Creek		500
Piney Creek		1,000
Alabama—Continued.		
Bessemer, West Lake		180
Birmingham, Cahawba Lake		200
Central Waterworks Reservoir		450
Giles Pond		400
Lake Alethea		300
McDermott's lake		300
Mountain Lake		200
Warren's lake		300

[a] Lost in transit, 3,376 fingerlings.

DISTRIBUTION OF FISH AND FISH EGGS, BY LOCALITY AND SPECIES, FISCAL YEAR 1913—Continued.

LARGE-MOUTH BLACK BASS—Continued.

Disposition.	Fry.	Fingerlings, yearlings, and adults.
Alabama—Continued.		
Blount Springs, Mill Creek		200
Carrollton, Bear Creek		100
Lubbub Creek		200
Lubbub Creek Pond		225
Courtland, Big Nance Creek		2,000
Cuba, Culpepper's pond		100
Jarman Lake		200
Cullman, Ayans Creek		300
Decatur, Swan Lake		300
Epes, Herrings Pond		100
Hylton's pond		100
Eutaw, Big Creek		300
Lamb's pond		300
Flomaton, Brown & Kiser's pond		465
Fort Payne, Black Oak Creek		300
Crystal Lake		300
Sand Valley Creek		100
Town Creek		300
Grimes, Johnson Lake		100
Hackleburg, Brewer Pond		200
Haleyville, Bear Creek		200
Flat Creek Pond		200
Wiley Pond		200
Huntsville, Braham Spring Pond		200
Briar Fork Creek		700
Indian Creek		1,400
Mastin Lake		200
Jeff, Trout Bayou		150
Kaolin, Young's pond		100
Millport, Gentrys Mill pond		100
Paint Rock, Paint Rock River		1,000
Panola, Lake Lala		250
Price's lake		450
Phil Campbell, Bishop's ponds		400
Russellville, Burgess Pond		200
Hale's pond		200
Hurst's pond		200
Lake Charles		200
Lake Galey		200
Sheffield Pond		200
Sloss Lake		200
Scottsboro, Kirby Creek		500
Seale, Dudley's pond		250
Spruce Pine, Hamilton Creek		200
Sulligent, Maddox Pond		100
Town Creek, Meadow Lake		1,000
Tuscaloosa, Coobs Creek		100
Cribbs Creek		100
Union Springs, Pond Place Pond		100
Valley Head, Burlison's pond		100
Vance, A. G. S. Reservoir		100
Vance Ponds		100
Whitney, Lake St. Ashville		100
Woodstock, Herring Lake		150
Ray's pond		150
Arkansas:		
Arlberg, Little Red River		120
Argenta, Hills Lake		1,700
Atkins, Lake Galla		200
Blevins, Slagle's pond		100
Clarksville, Spadra Creek		240
Danville, Dutch Creek		80
Dardanelle, Spring Pond		100
Venus Lake		100
Dermott, Bartholomew Bayou		400
Dierks, Holly Creek		250
Edmondson, Long Lake		750
Elkins, White River		90
Arkansas—Continued.		
Farrell, Farrell Lake		600
Harris Lake		600
Hardy, Forty Islands Creek		300
Spring River		900
Higden, Little Red River		60
Hot Springs, Spring Lake		100
Imboden, Spring River		1,200
Lancaster, Frog Bayou		80
Little Rock, Club Lake		800
Faulkner's lake		600
Malvern, Throne's pond		500
Mammoth Spring, Spring River		525
Many Islands, Myatt Creek		900
Spring River		70
Marked Tree, St. Francis River		411
Meadows, Frog Bayou		50
Mena, Mena City Lake		170
Miller, Little Red River		60
Monticello, Bermuda Stock Pond		200
Mulberry, Mulberry River		380
Little Mulberry Creek		300
Ozark, Horsehead Creek		80
Mulberry River		400
Plainview, Lumber Pond		600
Pocahontas, Black River		450
Eleven Points River		450
Rosston, Haynie's pond		600
Rottaken, Big Lake		400
Clear Creek		300
Fish Creek		200
Fourche Bayou Creek		200
Grassy Lake		400
Horseshoe Lake		200
Kuykendall Lake		400
Lorance Creek		300
Maple Creek		200
Pennington Bayou		200
Wolf Bayou		300
Russellville, Berryhill Lake		80
Illinois River		120
Scotts, Chinault Lake		600
Horseshoe Lake		760
Old River		760
Plum Bayou Lake		160
Shirley, Red River		60
Texarkana, Hay's pond		600
Thompson, Mountain Lake		90
Toltec, Mound Lake		600
Van Buren, Lee's creek		50
Vandervoort, Hickory Pond		300
Wilmot, Lake Enterprise		150
California:		
East Auburn, Imperial Lake		166
Colorado:		
Boulder, Boulder Lake		150
Burk Lake		150
Dollar Lake		120
Hygiene Lake		150
Denver, Keiss Reservoir		80
Perrin Lake		80
Florence, Sanders Lake		40
Fort Collins, Drake & Culver pond		80
Grand Junction, Grand River		225
Gunnison River		225
Redlands Pond		150

DISTRIBUTION OF FISH AND FISH EGGS, BY LOCALITY AND SPECIES, FISCAL YEAR 1913—Continued.

LARGE-MOUTH BLACK BASS—Continued.

Disposition.	Fry.	Fingerlings, yearlings, and adults.
Colorado—Continued.		
Niwot, Ward Lake		80
Steamboat Springs, Yampa River		150
Sterling, Point of Rocks Lake		160
Connecticut:		
Coscob, Pipe Stove Lake		50
Danbury, Keystone Lake		50
Greenwich, Putnam Lake		60
Twin Brothers Brook		50
Mystic, Beebe Pond		25
South Norwalk, Crystal Lake		30
Holy Ghost Pond		45
Waterbury, Lake Quassapaug		25
Westbrook, Chapman mill pond		30
Delaware:		
Harrington, Courseys Pond		100
Laurel, Chipmans Mill pond		100
Records Mill pond		25
Trussoun Mill pond		25
Milton, Fanganikj Lake		50
Lavinas Lake		75
Old Flume Mill Pond		50
Russell's lake		100
Wilmington, Brandywine Creek		420
Delaware River		500
Richardson Creek		50
Florida:		
Cypress, Burns Pond		500
De Funiak Springs, New Home Pond		1,000
East Lake, Lake Weir	2,250	
Florence Villa, Lake Lucerne		400
Lake Park, Red Eye Pond		2,000
Leesburg, Dupuy's lake	1,500	
Manatee, Johnson's pond		2,000
Milton, Collins Mill Creek		500
Mohawk, Lake Mabel		450
Monticello, Faglic's pond		500
Silver Lake		2,000
Wolf Pond		1,000
St. Petersburg, Saw Grass Lake		2,000
Santos, Bryant Pond		1,500
Wildwood, Waldron Lake		1,000
Georgia:		
Albany, Muckalee Creek		1,000
Ashburn, Lake Minnie		500
Athens, Oconee River		1,000
Atlanta, Lake Brookhaven		250
Smith & Williamson's mill pond		1,000
Augusta, Big Spirit Creek		4,000
Hancock Lake		4,000
Tabb Pond		2,200
Baconton, Adams's pond		2,000
Bainbridge, Lake Douglas		1,000
Ball Ground, Sharp Mountain Creek	2,000	
Beards Creek, Swindle's mill pond		1,000
Berryton, Turner's pond		1,000
Blythe, Templeton's pond		1,000
Box Springs, Lake Mohignac		2,500
Braswell, Lake Robert		500
Bronwood, Oliver Mill Ponds	1,000	
Cedartown, Davis's pond		1,000
Chatsworth, Holly Creek		3,500
Rock Creek		2,000

Disposition.	Fry.	Fingerlings, yearlings, and adults.
Georgia—Continued.		
Clarkston, Morris's pond		500
Clayton, Chattooga River		2,000
Conyers, Big Haynes Creek		200
Cordele, Collins's pond		500
Ray's pond		500
Covington, Alcovy Creek		500
Yellow River		500
Crawfordville, Little River		500
Reed Lakes		1,000
Cuthbert, Bridges Pond	2,250	
Butler's pond	1,250	
Dunn's pond	1,000	
Gormley Pond	1,000	
Dallas, Humphries Mill pond		500
Douglas, Forkey Creek		2,000
Story Pond		500
Eatonton, Jones Pond		1,000
Lake Imperial		1,000
Faceville, Betts Mill pond		1,000
Fairburn, Brantley's pond		1,000
Hormsbys Mill pond		1,000
Fayetteville, Bartlett Pond		500
Bennetts Mill pond	1,000	
Gainesville, Lake Lanier		1,000
Glenn, Barrett's pond		750
Glenville, Norman's pond		175
Graysville, Hurricane Creek		1,000
Hagan, Hodges's pond		500
Kennedy's pond		500
Harrison, Brantley Ponds		1,000
Hillsboro, Cedar Creek		2,000
Cedar Creek Pond		500
Hughland, Battle Pond		175
Jackson, Ocmulgee Lake		2,000
Jasper, Mill Creek	2,000	
Jefferson, Gordon's pond		300
Mulberry River		2,000
Pond Fork River		1,000
Stark's pond		1,000
Walnut River		1,000
Junction City, Porter Lake		1,000
Leary, Corson's pond		1,000
Daniell's pond		1,000
Lumpkin, Hodchodkee Creek		1,000
McCollum, Thompson's pond		1,000
Mableton, Mable's pond		500
Macon, Nelsons Mill pond		1,000
Madison, Silver Lake		1,000
Manassas, Cartee's pond		500
Mariette, Waterworks Lake		1,000
Milledgeville, Beever's pond		375
Colony Pond		1,000
White Lake		1,000
Mitchell, Lyons's pond		1,000
Monticello, Ocmulgee River Pond		3,000
Still House Lake		2,000
Moreland, Bingham's pond		500
Newborn, Child's pond		2,000
Nickajack, Nickajack Creek		3,000
Osierfield, Tucker's pond		125
Palmetto, Winkles's pond		1,000
Pearson, Poplar Branch Pond		1,500
Preston, Chattahoochee Creek		2,000
Schlatterville, Dowling's pond		500
Senoia, Brown's pond		500
Stone Mountain, Venable Lake		500
Talking Rock, Hamrick's run		500
Tarrytown, Cypress Creek Pond		175

DISTRIBUTION OF FISH AND FISH EGGS, BY LOCALITY AND SPECIES, FISCAL YEAR 1913—Continued.

LARGE-MOUTH BLACK BASS—Continued.

Disposition.	Fry.	Fingerlings, yearlings, and adults.
Georgia—Continued.		
Thomasville, Hambleton Pond		500
Tiger, Little Creek		1,000
Trimble, Guin Pond		2,000
Union City, Lake Nelida		1,000
Valdosta, Boyds Lake		500
Lake Laurel		500
Indian Pond		500
Ocean Pond		573
Vidalia, Darby's pond		175
Ways Station, Ogeechee River		2,000
Willacoochee, Haskins's pond		625
Wrens, Ex Gin Pond		1,000
Wildwood, Popes Creek		1,000
Woodburn, Lake Lookout		2,000
Idaho:		
Genesee, Brigham Lake		75
Idaho Falls, Rainbow Ponds		16
Soda Springs, Homer Creek Reservoir		32
Illinois:		
Anna, Eddleman's pond		200
Belleville, Heinemann Lake		375
Carthage Junction, Orchard City Lake		800
Carterville Burr Pond		200
Centralia, Lake Centralia		600
Decatur, Decatur Club Lake		1,100
Dixon, Rock River		600
Dupo, Falling Spring Lake		100
Duquoin, Forester Mine Pond		375
Eldorado, Boyd Pond		400
Elizabeth, Apple River		525
Flora, Flora Reservoir		200
Glen Carbon, Barnsback Lake		200
Golconda, Grassy Pond		200
Riggs Ponds		200
Hallidayboro, Hallidayboro Pond		375
Herrin, Cash's pond		375
Highland, Gravel Lake		400
Oak Hill Lake		400
Marshall, Crystal Lake		800
Meredosia, Illinois River		400
Nashville, Carlsbad Lake		400
Oakland, Embarras River		65
Sandwich, Fox River		300
Sparta, Country Club Lake		400
Crothers Lake		200
Tiskilwa, Illinois & Mississippi Canal		600
Toulon, Green's pond		200
Vienna, Chestnut Hill Lake		400
Xenia, Brinton's lake		200
Indiana:		
Acton, Buck Creek		200
Albion, Rittenhouse Lake		125
Anderson, Arcade Pond		150
Perry's pond		300
West Brook		150
Angola, Lake James		250
Atwood, Huffman Lake		250
Boonville, Waterworks Lake		300
Bremen, Lake of the Woods		250
Brooklyn, Jewel Lake		250
Cambridge City, Whitewater River, West Fork		300
Cedar Lake, Cedar Lake		375
Columbia City, Loon Lake		250
View Pond		100
Corydon, Gilham Lake		100
Kings Cave Lake		100
Crandall, Big Indian Creek		300

Disposition.	Fry.	Fingerlings, yearlings, and adults.
Indiana—Continued.		
Crawfordsville, Water Babble Ponds		300
Culver, Lake Maxinkuckee		250
De Long, Tippecanoe River		250
Elkhart, Elkhart River		250
Elwren, Richland Creek		300
Evansville, Davidson's lake		100
Keil's lake		100
Welborn's pond		100
Ferdinand, Silver Lake		100
Franklin, Sugar Creek		300
Fremont, Lake George		250
Fort Wayne, St. Marys River		250
Fulton, South Lake		250
Goodland, Moran Pond		125
Greenfield, Spring Lake		150
Greens Fork, Greens Fork Creek		300
Hammond, City Park Lake		125
Hartford City, Newbauer's gravel pond		150
Howe, South Twin Lake		250
Huntingburg, Asb Pond		100
City Waterworks Lake		200
Pearl Pond		125
Salamonie River		250
Indianapolis, Eagle Creek		400
Hanch's pond		200
White River		350
Jasper, Calumet Lake		150
Prospect Pond		150
Kentland, Woodruff Lake		125
Lake Gage, Perch Lake		125
Larwill, Big Cedar Lake		250
Leesburg, James Lake		250
Oswego Lake		250
Lena, Alma Lake		200
Liberty, Poplar Springs Pond		200
Whitewater River, East Fork		300
Marion, Mississinewa River		300
Milroy, Barton's pond		100
Muncie, White River		450
New Albany, Graf Pond		150
Noblesville, Carr's pond		150
North Vernon, Miller Pond		100
Muskatatuck River		150
Odon, Spring Pond		250
Otis, Hildebrand's lake		125
Peru, Eel River		250
Mississinewa River		250
Plymouth, Lake of the Woods		375
Pretty Lake		250
Twin Lakes		375
Ray, Clear Lake		250
Long Lake		250
Richmond, Ballinger's lake		150
Richmond Lake		300
Roann, Lukens Lake		125
Rose Lawn, Kankakee River		250
Seelyville, Phillips Pond		100
Sellersburg, Quarry Pond		150
Shelbyville, Big Lewis Creek		300
Little Blue River		300
South Bend, Clear Lake		250
St. Josephs Lake		250
Stewartsville, Toots Lake		150
Sunman, Longs Mill Pond		125
Summitville, McLain's pond		150
Roseboom's pond		150

DISTRIBUTION OF FISH AND FISH EGGS, BY LOCALITY AND SPECIES, FISCAL YEAR 1913—Continued.

LARGE-MOUTH BLACK BASS—Continued.

Disposition	Fry.	Fingerlings, yearlings, and adults.
Indiana—Continued.		
Templeton, Big Pine Creek		250
Terre Haute, Parker's pond		100
Thorntown, Sugar Creek		450
Union City, Little Missionowa Ponds		150
Valparaiso, Flint Lake		250
Long Lake		250
Vincennes, Wabash Lake		500
Vistula, Stone Lake		250
Wabash, Mississinewa River		250
Walkerton, Koontz Lake		250
Washington, Holder's pond		200
Waveland, Sugar Creek		450
White Pigeon, Hunters Lake		250
Stone Lake		250
Winona, Winona Lake		375
Worthington, Eel River		400
Iowa:		
Albia, Albia City Reservoir		100
Amana, Amana Lake		200
Anamosa, Buffalo River		120
Arlington, Bear Creek		20
Austinville, Austinville Pond		80
Ayrshire, Silver Lake		100
Bellevue, Mississippi River		14,100
Bloomfield, Burchett Lake		100
Burlington, Lone Tree Lake		400
Chester, Upper Iowa River		120
Clarion, Elm Lake		240
Clear Lake, Clear Lake		80
Coggon, Buffalo Creek		80
Wapsie Bayou		80
Colfax, Ellsworth's pond		100
Creston, Summit Lake		200
Decorah, Power Company Lake		40
Drakeville, Calvert's pond		100
Dyersville, Marquette River		120
Eldora, Iowa River		60
Fairfield, New Pond		150
Waterworks Pond		150
Fort Atkinson, Turkey River		80
Fort Madison, Chapman's pond		50
Glenwood, Glenwood Lake		150
Hampton, Beeds Lake		40
Independence, Wapsipinicon River		4,800
Le Mars, Dalton's pond		40
Grimes Lake		40
Lime Springs, upper Iowa River		4,600
Lorimor, Willow Pond		100
Manning, Great Western Pond		100
Mason City, Lime Creek		80
McIntire, Wapsipinicon River		100
Minden, Hesleys Lake		100
Monona, Monona Lake		20
Ottumwa, Burns Lake		250
Morriseyville Lake		150
Riceville, Little Cedar River		60
Ruthven, Lost Island Lake		100
Tama, Deer Creek		200
Tingley, Farm Pond		200
Wapello, Heins Lake		100
Waterloo, Cedar River		4,850
Kansas:		
Baileyville, Horseshoe Pond		200
Columbus, Crystal Lake		250
Spring Lake		250
Fort Scott, Paint Creek		300
Galena, Evans Pond		250
Hillsdale, Bull Creek		400
Kansas—Continued.		
Huron, Huron Pond		400
Independence, Bennetts Lake		200
Sawyer's pond		100
Kingman, Long Pond		100
Wrenchey's pond		100
Paola, Wea Creek		250
Peabody, Doyle Creek		200
Tyro, Tyro Lake		250
Kentucky:		
Albany, Cumberland River, tributaries		200
Albia, Caney Creek		400
Allensville, Bibb's pond		175
Bourbon, Crystal Lake		200
Bowling Green, Covington's pond		175
Martin's pond		175
Smith's pond		175
Toop's pond		175
Brumfield, Crane's pond		200
Burkesville, Alexander's pond		200
Burnside, Cumberland River		400
Cadiz, Muddy Fork Creek		250
Cave City, Curd's pond		125
Well's pond		125
Covington, Decker's lake		100
Meadowbrook Lake		100
Crofton, Crofton Lake		175
Danville, Dix River		400
Elizabethtown, Bailey's pond		325
Farmers, Triplett Creek		200
Ferguson, Darby's pond		175
Franklin, Anderson Pond		100
Butt's pond		100
Dunn's branch		100
Garrison's pond		100
Harris Pond		100
Haydon's pond		100
Lake Thelma		150
Laney's pond		100
Lick Creek		150
McGlothlin's pond		100
Reden Mill Pond		150
Robbin's pond		100
Terrapin Creek		100
Whippoorwill Creek		100
Fredonia, Livingston Creek		250
Willow Pond		200
Georgetown, North Elkhorn Creek		400
Glasgow, Beaver Creek		300
Redford's willow pond		125
Greensburg, Green River		400
Guthrie, Elk Fork Creek		300
Harlan, Kentucky River, Martins Fork		400
Hartford, Rough River		300
Herndon, Dawson's pond		200
Nance's pond		100
Redford Pond		100
Hodgenville, Allen Pond		75
Creal's pond		150
Cundiff's pond		150
McDowell Lake		200
Martin's pond		325
Miller's pond		175
Munford's pond		225
Walter's pond		300
Weldon Pond		275
Wyatt's pond		225
Howell, Crenshaw's pond		200

DISTRIBUTION OF FISH AND FISH EGGS, BY LOCALITY AND SPECIES, FISCAL YEAR 1913—Continued.

LARGE-MOUTH BLACK BASS—Continued.

Disposition.	Fry.	Fingerlings, yearlings, and adults.
Kentucky—Continued.		
Hunters, The Cedars Pond		200
La Grange, Highland Lake		200
Irwin Pond		100
Rayan's pond		100
Lawrenceburg, Crook's pond		200
Rice's pond		200
Lebanon, Fairview Lake		200
McElroy's pond		400
Lexington, Darby's pond		200
Liberty, Green River		400
Louisville, Lake Lansdowne		800
Shadyside Lake		100
Silver Lake		400
McBrayer, Salt River		500
Madisonville, Eastern Lake		300
Spring Lake		300
Marion, Piney Creek		150
Maysville, Kirk's pond		25
Locust Lake		25
Robinson's pond		25
Middlesboro, Fern Lake		1,000
Millersburg, Kates Pond		200
Monticello, Beaver Creek		600
Morning View, Morning View Lake		100
Mount Sterling, Anderson's pond		200
Morris Pond		200
New Hope, New Hope Lake		200
Newport, Horseshoe Pond		100
Newtown, Elkhorn River		400
Nicholasville, Ambrose Lake		200
Church Pond		200
Lake Mingo		400
Olive Hill, Tygart Creek		400
Olmstead, Shady Grove Pond		17
Wyatt's pond		125
Owensboro, Bud Lake		175
Paris, Backwoods Pond		200
Bedford's pond		200
Ferguson's pond		200
Hall's pond		200
Lowry Pond		200
Woodford's pond		200
Petersburg, Woolper Creek		150
Pineville, Clear Creek		400
Princeton, Woods Pond		150
Richmond, Lakes Reba		400
Shackleford's pond		400
Russellville, Miller's pond		125
Ryan's pond		200
Pulliam Pond		125
Mud River		125
Sanders, Carlisle's pond		100
Somerset, Condiff's pond		200
Stanford, Dishon's pond		200
Dix River		400
Hanging Fork Creek		200
Stearns, Rock Creek		400
Sturgis, Cannon Pond		100
Tip Top, Montgomery's pond		225
Orthober pond		225
Tip Top Lake		150
Tonieville, Harned's pond		150
Trenton, Byar's pond		100
Crutchfield's pond		175
Vanarsdell, Salt River		500
Vanceburg, Kinniconick Creek		75
Waynesburg, Buck Creek		400
Gilmore Creek		200
White Station, Goodloe's lake		200
Williamsburg, Cumberland River		200
Kentucky—Continued.		
Winchester, Electric Light Pond		200
Strong's pond		200
Woodburn, Buckner Pond		100
Clear Pond		125
Crystal Pond		175
Double Pond		100
McElwain's pond		125
Pope's pond		100
Willow Pond		100
Louisiana:		
Arcadia, James's pond		100
Bayou Sara, Troy Lake		100
Greenwood, Lake Hayes		120
Gulletts, Glenwood Farm Pond		100
Saal Pond		200
Gurley, Highland Pond		200
Island Pond		250
Lindsay, McKowen's pond		500
Mills Pond		200
Marion, Dukes Pond		75
Fitzgerald's pond		75
New Orleans, City Park Lake		200
Seaboard Pond		100
Ponchatoula, Tangipahoe River		300
Ruston, Lyle's pond		100
Sheppard Lake		100
Shreveport, Bayou Pierre Lake		100
Spring Lake		100
Stevendale, Jumping Gulley Pond		200
Maryland:		
Alberton, Wheelright's pond		400
Alesia, Big Gunpowder River Dam		250
Ammendale, Hughes's pond		125
Annapolis, Junior Republic Pond		125
Baltimore, Monocacy River		450
Berlin, Trappe Creek		200
Betterton, Lloyds Creek		100
Bishop, St. Martins River		200
Bowie, Spring Lake		250
Buck Lodge, Darby's mill pond		125
Chestertown, Ratcliffe Pond		100
Contee, Carroll's pond		125
Cropley, Potomac River		500
Cumberland, Potomac River		365
Potomac River, North Branch		125
Detour, Double Pipe Creek		500
Elkton, Back Creek Mill Pond		50
Frederick, Monocacy River		250
Greenmount, Gunpowder Falls Creek		250
Greensboro, Choptank River		75
Hagerstown, Antietam Creek		500
Hoods Mill, Patapsco River		250
Hyattsville, Anacostia River, Northwest Fork		250
Jefferson, Catoctin Creek		250
Keymar, Big Pipe Creek		250
Lansdowne, Lake Rosalie		125
Maple Grove, Gunpowder Falls Creek, tributary		125
Marydel, Choptank Mill Pond		50
Millington, Midlington Mill pond		50
Unicorn Roller Mill pond		75

DISTRIBUTION OF FISH AND FISH EGGS, BY LOCALITY AND SPECIES, FISCAL YEAR 1913—Continued.

LARGE-MOUTH BLACK BASS—Continued.

Disposition.	Fry.	Fingerlings, yearlings, and adults.
Maryland—Continued.		
Mount Washington, Lake Roland		250
Mount Winans, Silver Lake		125
Oxenhill, Jenkin's pond		250
Pocomoke, Pocomoke River		300
Wagram Pond		200
Welbourn Pond		100
Portobella, Flag Lake		125
Rockville, Rock Creek		250
Roxbury, Antietam Creek		250
Silver Springs, Northwest Branch		220
Taneytown, Bear Branch		250
Fish Pond		250
Williamsport, Conococheague Creek		500
Potomac River		250
Massachusetts:		
Mount Hermon, St. Patricks Pond		50
Plymouth, South Triangle Pond		150
Wareham, Little Sandy Pond		50
White Pond		50
Worcester, Asnebumskett Pond		50
Michigan:		
Alpena, Grand Lake		400
Arnheim, Otter Lake		250
Central, Gratiot Lake		175
Charlotte, Burnett Park pond		75
Clare, Dewey Lake		120
Champion, White Deer Lake		200
Crystal Falls, Holmes Lake		250
Delaware, Beaver Lake		175
Bete Grise Bayou		175
Deer Lake		175
Lac La Belle		175
Lake Bailey		250
Detroit, Detroit Aquarium		80
Gaylord, Otsego Lake		160
Harrison, Budd Lake		210
Hillman, Long Lake		300
Iron River, Chicagoan Lake		350
Jones, Birch Lake		75
Shavehead Lake		75
Kenton, Lake Thirty Three		250
Lawrence, Deep Lake		25
Long Lake, North Lake		120
Mandan, Breakfast Lake		175
Lake Addie		175
Lake Medora		175
Schlatter Lake		175
Newaygo, Turtle Lake		50
Norwalk, Bear Lake		75
Peacock, Big Bass Lake		75
Ramona, Diamond Lake		75
Rose Center, Bennet Lake		80
Southbranch, Bobs Pond		80
Traverse, Boardman Lake		800
Union City, Lee Lake		75
Turtle Lake		75
White Cloud, Snyder Lake		75
Minnesota:		
Beaudette, Four Mile Bay		100
Brimson, Bates Lake		100
Indian Creek		125
Indian Lake		100
Carlton, Chub Lake		120
Deerwood, Lake Prano		90
Duluth, Caribou Lake		90
Deep Water Lake		60
Island Lake		90
Lake Fredenburg		110
Minnesota—Continued.		
Duluth, Lake Gladys		90
Rice Lake		90
Schultz Lake		60
Ely, Little Long Lake		100
Shin Lake		100
Stony River		100
Jenkins, Hay Lake		90
Knife River, Micmac Lake		100
Moose Lake		100
Nine Mile Lake		100
Lutsen, Lake Christina		90
Mahtowa, Park Lake		150
Moose Lake, Moose Lake		300
Pengilly, Swan Lake		150
Rollins Siding, Brown Lake		100
Moose Lake		100
White Lake		100
Wolf Lake		100
Sawyer, Big Lake		90
Moosehorn Lake		90
Perch Lake		90
Taylors Falls, St. Croix River		70
Virginia, Sand Lake		150
Wolf Station, Lake Crystal		150
Mississippi:		
Aberdeen, Arratt Pond		500
Dead River Club Lake		500
Homer Pond		500
Horseshoe Lake		150
Nash Lake		150
Pea Ridge Lake		500
Quofoloma Lake		150
Tombigbee River		1,000
Twin Lake		500
Ackerman, Rock Pond		500
Amory, Tombigbee River		1,000
Basic City, Malpus Pond		100
Belden, Ritter's pond		500
Bentonia, Fairview Pond		100
Booneville, Booneville Lake		200
Burton's pond		200
Clear Lake		1,000
Gin Branch Pond		100
Jones's lake		150
Brookhaven, Brickyard Pond		50
Caraway's pond		50
Canton, Big Lake		200
Brown Lake		200
Canton Farm pond		150
Foot's pond		200
McBride's pond		200
Mosby Pond		200
Peach Lake		200
Rick's lake		300
Round Lake		200
Williams's lake		400
Centerville, Lake Antoinette		200
Clayton, Clear Lake		100
Columbia, Simmon's pond		400
Simmons Mill pond		200
Spring Pond		200
Corinth, Artesian Lake	4,000	
Bills Park Lake		1,000
Calacanthis Lake		1,000
Eates Pond		1,000
Long Hollow Pond	1,000	
Sharp's pond		1,000
Smith's pond	1,000	
Strickland's lake	1,000	
Surratt's lake	2,000	
Turner's pond		1,000
Tuscumbia Cutoff Lake		1,000

DISTRIBUTION OF FISH AND FISH EGGS, BY LOCALITY AND SPECIES, FISCAL YEAR 1913—Continued.

LARGE-MOUTH BLACK BASS—Continued.

Disposition.	Fry.	Fingerlings, yearlings, and adults.
Mississippi—Continued.		
Corinth, Vandiver's lake		1,000
Weedon's pond		1,000
Waukomis Lake		1,200
Dubard, Alligator Pond		100
Edwards, Crissler's pond		350
Hewes's pond		150
Egypt, King's pond		500
Linn's pond		500
Fenwick, Fenwick Pond		250
Flora, Hawkins's ponds		200
Lipscomb's pond		100
Grisham's pond		100
Forest, Wicker's pond		24
Greenwood Springs, Buttahatchie River		500
Greenwood Springs, Sipsy River		500
Guntown, Brownlee Lake		16
Public Pond		16
Hattiesburg, Longre & Mitchell Lake		200
Hazlehurst, Branard's lake		25
Ellis Lake		25
Lake Hazel		25
Martin's pond		25
Hodges, Hodges Reservoir		200
Horn Lake, Coggin's pond		100
Winn's pond		200
Holly Springs, Wall's Pond		500
Houlka, Hollingsworth Pond		500
Houston, Evans's pond		500
Huffman's pond		500
Lake View		500
Lowry's pond		500
Mary Alma Lake		500
Iuka, Iuka Lake		32
Lake Como		66
Jackson, Cades Lake		200
Clear Lake		200
Crowder's lake		30
I. C. Pond		300
Lynch Creek		200
Mule Jail Lake		200
Oak Ridge Lake		200
Spring Lake		200
Johnson Junction, Park Lake		400
Kewanee, Wright's pond		200
Lake, Brown's ponds		300
Lexington, Acona Mill pond		600
Louisville, Bethedan Pond		200
McLean's pond		200
Water Valley Lake		200
Lucedale, Jones's pond		100
Lyman, Reservoir Pond		200
McComb, Clear Creek		50
Clement Lake		50
Illinois Central Lake		300
Lake McComb		50
McRaven, East Pond		200
Macon, Dugan Pond		500
Lillie Pond		600
Marshall Lake		1,000
Minor Pond		600
Magnolia, Mullin's branch		50
Strickland's branch		50
Mantee, Durham's pond		500
McGee's pond		500
Moseley Pond		500
Meridian, Ethridge Pond		25
Fishing Club Pond		300
Lake Nani Waiah		25
Queen City Pond		50
Rolling Pond		200
Mississippi—Continued.		
Meridian, Wagner Pond		50
Waterworks Pond		50
Minter City, Virginia Lake		300
Mize, Robinson's pond		100
Moon, Moon Lake		50
Monticello, Lambert's pond		200
Morton, Vinsons Mill pond		200
Muldon, Evans's lake		400
Myrtle, Frazier's pond		500
Neshoba, Henderson's pond		200
Watkin's pond		200
New Albany, Clear Pond		500
Pinedale Pond		500
Rainey's pond		500
Sanford's pond		500
New Augusta, Barbara Pond		150
McSwain's pond		200
Newton, Chapman's pond		50
Walker's pond		200
Osborn, Boyd's pond		200
Love's pond		200
Ovett, Smith's pond		150
Pelahatchie, Patrick's pond		24
Philadelphia, Hester's pond		200
Kantarka Pond		200
Pearl River		200
Shocalo Pond		200
Silver Loaf Pond		200
West View Pond		200
Picayune, Tate's pond		100
Pontotoc, Brown's pond		1,000
Davis Pond		500
Pontotoc Pond		1,000
Prentiss, Polk Lake		200
Raymond, Ratliff's pond		50
Wade's pond		25
Redwood, Cole's pond		200
Richton, Conway's pond		200
Robinwood, Robinson's pond		200
Saltillo, Bucy's pond	1,000	.....
Park's pond	1,000	.....
Saltillo Lake		500
Sandersville, Andrews Mill pond		200
Seminary, Oakatoma Pond		200
Pearson & Watson Pond		200
Senatobia, Willow Pond		200
Sessums, Foster's pond		150
Sherard, Dogwood Lake		50
Shuqualak, Anderson's ponds		400
East Side Lake		500
Floore's pond		500
Goodwin's pond		500
Hamilton's pond		200
Ogletree Lake		500
Pine Grove Pond		200
Prince's pond		500
Quarles Pond		500
Stevens's pond		500
Walton's pond		500
Water Lily Pond		500
West End Lake		500
Stallo, Jackson's pond		50
Starkville, Ellis Pond		40
Gillis Pond		40
Jones's pond		150
Kennard's pond		80
McPherson Lake		200
Montgomery's pond		200

DISTRIBUTION OF FISH AND FISH EGGS, BY LOCALITY AND SPECIES, FISCAL YEAR 1913—Continued.

LARGE-MOUTH BLACK BASS—Continued.

Disposition.	Fry.	Fingerlings, yearlings, and adults.
Mississippi—Continued.		
Starkville, Park Lake		30
Robson's pond		80
Sander's pond		30
Sudduth's pond		150
Sykes Pond		40
Talking Warrior Lake		200
Watt's pond		200
Wellborn pond		80
Stringer, Stringer's pond		100
Strongs, Dream Lake		150
Sturges, Hutchinson's pond		200
Summerland, Williams's pond		100
Taylorville, Keys Mill pond		200
Terry, Jones's pond		100
Tishomingo, Holley's lake		200
Tunica, Kinney Lake		50
Tupelo, Beaver Lake		500
Chiwappa Creek		500
Parham Pond		500
Ray's lake		200
Town Creek		500
Vaiden, Armstrong's pond		200
Union, Frog Hollow Pond		200
Utica, Downing's pond		15
Waynesboro, Bushby's pond		100
Weir, Black's pond		200
Fry's pond		200
Stubblefield's pond		200
Whitesand, Trexler's pond		200
Wiggins, Batson's pond		100
West Point, Brogan's pond		500
Cottrell's pond		500
Hamlin's ponds		1,000
Twin Ponds		200
Westbrook's pond		500
Missouri:		
Ash Grove, Spring Lake		200
Birch Tree, Current River, Jacks Fork		100
Bunceton, Doctors Creek		250
Idlewood Lake		425
Lamine River		425
Moneteau Creek		425
Petite Saline Creek		425
Cabool, Piney River		450
Centralia, Lake Dutcher		275
Clinton, Fish Lake		600
Dexter, Spring Hill Lake		300
Dodson, Rule Farm Lake		600
Ethel, Ethel Pond		100
Fortescue, Big Lake		100
Harviell, Cane Creek		300
Helena, Lillibridge Lake		180
Hutton Valley, Hickory Grove Pond		150
Independence, Juanita Lake		450
Milton's lake		300
Jasper, Birds Lake		200
Coon Creek		300
Jaudon, Grant's pond		300
Jefferson City, Moreau Creek		400
Joplin, Thomas Lake		300
Kansas City, Fairmount Lake		450
Kiger Farm Lake		250
Lamar, Gregory Lake		650
Spring River, North Fork		650
Lisle, Lisle Pond		450
Missouri—Continued.		
La Plata, Love Lake		200
Santa Fe Lake		200
Macon, Blees Lake		150
Martin City, Oak Park Lake		450
Mexico, Quitapahila Lake		828
Monteer, Current River, Jacks Fork		450
Nevada, Katy Allen Pond		300
State Hospital Lake		150
Newburg, Little Piney River		450
New London, Salt River		400
Noel, Elk River		1,800
Ozark, Finley River		450
Pleasant Hill, Kellogg's lake		395
Lake Leonard		450
Smith's lake		300
Randolph, Winn's lake		400
Rolla, Big Dry Fork Creek		150
Big Piney River		450
Big Spring Creek		200
Burpois Creek		450
Cave Springs Creek		450
Gasconade River		450
Little Beaver Creek		200
Little Dry Fork Creek		300
Little Piney Creek		850
Mill Creek		300
North Mill Creek		200
South Spring Creek		350
St. Genevieve, Schwartz's pond		250
Savannah, Blakeslee's lake		80
Seneca, Big Lost Creek		300
Wappapello, St. Francis River		100
Watson, Brown's pond		150
Wayland, Hill Slough		100
Willow Springs, Frisco Pond		900
Worth, Dye's pond		90
Montana:		
Bascom, Holman's pond		24
Eureka, Rock Lake		34
Whitefish, Blanchard Lake		34
Nebraska:		
Crawford, White Clay Creek		20
Scottsbluff, Airedale Pond		30
Verdon, Harden's lake		225
Wayside, Baird's pond		35
New Hampshire:		
Plymouth, Loon Lake		50
New Jersey:		
Alloway, Elkinton		80
Beaver Lake, Lake Pochuck		50
Blairstown, Cedar Lake		50
Fairview Lake		50
Boonton, Mountain Lakes		80
Bound Brook, Middle Brook		25
Branchville, Culver Lake		200
Chatsworth, Bridge Creek		100
Cranford, Rahway River		80
Egg Harbor, Park Lake		200
Hackettstown, Allamuchy Pond		80
Guard Lock Pond		80
Hammonton, Hammonton Lake		200
Harrisonville, Oliphant Lake		80
Lake Hopatcong, Lake Hopatcong		200
Lakewood, Johnson's lake		60
Polypod Pond		200

DISTRIBUTION OF FISH AND FISH EGGS, BY LOCALITY AND SPECIES, FISCAL YEAR 1913—Continued.

LARGE-MOUTH BLACK BASS—Continued.

Disposition.	Fry.	Fingerlings, yearlings, and adults.
New Jersey—Continued.		
Lambertville, Emery's pond		40
Lucaston, Silver Lake		100
Mount Holly, Rancocas River		200
Upper Rancocas Creek		100
Murray Hill, Passaic River		100
Neshanic, South Branch River		50
Netcong, Budd Lake		50
Newark, Weequahic Lake		330
New Egypt, Oakford Lake		100
Pennington, Jacobs Creek		25
Pompton Lakes, Pequannock River		50
South Dennis, Clint Mill Pond		200
South Ogdensburg, Hawthorne Lake		50
Spring Lake, Spring Lake		200
Swartswood, Little Swartswood Lake		50
Waldwick, Rosecrans Pond		200
West End, Shadow Lawn Lake		100
Williamstown, Faraway Lake		100
McClure's lake		200
New York:		
Addison, Goodhue Lake		80
Bay Shore, Brightwater Lakes		400
Chatham, Kinderhook Creek		640
Clayton, St. Lawrence River		100
Colliers, Goodyear Lake		225
Corinth, Bull Head Pond		25
Effner Lake		50
Hunt Lake		50
Jenney Lake		50
Corning, Denison Park Lake		80
Cornwall, Bug Meadow Lake		200
Sutherland Pond		200
Fallsburg, Kiamesha Lake		120
Gouverneur, Oswegatchie River		50
Hammondsport, Lake Keuka		175
Hempstead, Slivers Lake		150
Highland Falls, Roe Park Lake		200
Java Center, Java Lake		75
Mastic, Home Creek		300
Millbrook, Tyrrel Lake		80
Monticello, Class Pond		40
Ogdensburg, St. Lawrence River		100
Perhonkson, Parry's pond		80
Petersburg, Taconee Lake		40
Poughkeepsie, Bahret's pond		40
Fairview Lake		100
Redwood, Grass Lake		125
Round Lake, Round Lake		200
Roscoe, Florence Lake		100
Schroon Lake, Schroon Lake		1,000
Sterlington, Potake Lake		300
Troy, Crooked Lake		200
Crystal Lake		200
Hayner Pond		200
Hudson River		300
Walden, Walkill River		500
Wallkill, Shawankill River		200
Warrensburgh, Echo Lake		80
Whitestone, Fort Totten Pond		200
Yulan, Montgomery Pond		70
Washington Lake		80
North Carolina:		
Advance, Pack's pond		75
Angier, Adams's pond		300
Adams's pond No. 2		100
Buies Creek		100
North Carolina—Continued.		
Angier, Collins's pond		100
Piney Branch Pond		150
Smith's pond		150
Apex, Castleberry's pond		100
Lawrence's pond		100
Sears's pond		100
Ararat, Bryant's pond		75
Asheboro, Little River		75
Bladensboro, Horse Pen Creek		200
Biscoe, Page's pond		200
Bowden, Rowland Lumber Co. pond		300
Burlington, Graves Pond		150
Sartin's pond		150
Somers's pond		100
Cairo, Johnsons Mill pond		150
Calypso, Sutton's pond		300
Cameron, Baldwin Pond		100
McDugald Pond		200
Pierce's pond		100
Candor, Cheeks Creek		200
Chadbourn, Hughes Mill Pond		200
Pages Mill pond		200
Charlotte, Lakewood Park Lake		300
Clarkton, Highs Mill pond		150
Clayton, Stallings's pond		100
Coats, Spring Branch Pond		100
Turlington's pond		150
Colon, Baling Pond		200
Moffitt's pond		100
Concord, Big Coldwater Creek		150
Buffalo Creek Pond		100
Rocky River		300
Cordova, Hitchcock Creek		100
Council, Carvers Creek		200
Creswell, Lake Phelps		400
Dunn, Grantham's pond		525
Surles Mill pond		400
Elkton, Smiths Mill pond		200
Enfield, Woodlawn Pond		158
Fayetteville, Blounts Creek pond		150
Campbell Pond		300
Cross Creek Pond		100
Eccles Pond		150
Huske Pond		150
McNeil's pond		100
Parkland Lake		250
Rockfish Creek, tributary of		150
Sky Pond		200
Fremont, Dickinson pond		100
Gastonia, Beal's lake		200
Cobb's lake		200
Lake Giles		200
Limberger Pond		200
Long Creek Pond		300
McAllister's lake		200
Gibsonville, Lakeview Mill pond		200
Godwin, Shop Branch		200
Goldsboro, Country Club Lake		327
Griffin's pond		200
Lake Genoa		300
Graham, Little Alamance Creek		150
Greensboro, Boren's pond		75
Gulf Lake		75
Hilton's pond		75
McKnight's pond		75
Phipps's pond		75
Willow Brook		75

DISTRIBUTION OF FISH AND FISH EGGS, BY LOCALITY AND SPECIES, FISCAL YEAR 1913—Continued.

LARGE-MOUTH BLACK BASS—Continued.

Disposition.	Fry.	Fingerlings, yearlings, and adults.
North Carolina—Continued.		
Hamlet, Fallen Creek Pond		100
Havelock, Catfish Lake		300
Henderson, Henderson Club Pond		300
Hiddenite, Stevenson Branch Pond		75
Hildebran, Henry River Pond		150
Holly Springs, Adams's pond		100
Ivanhoe, Beatty's pond		150
Jackson Springs, Blue's pond		100
Pooles Mill pond		100
Jacksonville, New River		175
Jonesboro, Big Creek		100
Kannapolis, Kannapolis Lake		200
Kernersville, Abbotts Creek Pond		75
Smith's pond		75
Kinston, Moseley's pond		100
Lake Waccamaw, Waccamaw Lake		400
Liberty, Polecat Creek		150
Quarter Pond		75
Lillington, Shaws Pond		100
Lincolnton, Catawba River, South Fork		200
Littleton, Big Stone House Mill Pond		200
Louisburg, Jackson's pond		550
Stalling's pond		200
McCullers, Mill Pond		100
Macclesfield, Brown's pond		200
Magnolia, Newkirk Mill Pond		200
Marshville, Lanes Creek		100
Matthews, Goose Creek Mill Pond		200
Stevens's pond		150
Maxton, Lumber River		300
Monroe, Richardson Mill pond		100
Shute's pond		150
Totten Fish Pond		100
Morganton, Catawba River		150
Johns River		150
Lower Creek		150
Lower Fork River		150
Pools Mill pond		150
Upper Creek		375
Morrisville, Crabtree Creek		200
Kit Creek		150
Sears's pond		175
Searl's pond		100
Stirrup Prong Creek		150
Morven, Pratt's pond		150
Robinson Pond		100
Mount Airy, Buckshoal Pond		75
Fishers River		150
Mount Holly, Catawba River		500
Dutchman's creek		200
Mount Olive, Goodson's pond		300
Williams Mill pond		300
Neuse, Barton Creek		100
Newbern, Neuse River and tributaries		175
Newport, Cypress Pond		200
North Wilkesboro, Mulberry Creek		450
Oxford, Tabs Creek Pond		300
Parkton, Davis Mill Pond		150
Pelham, Wolf Island Mill pond		75
North Carolina—Continued.		
Pembroke, Buies Mill Pond		400
Pinehurst, McKenzie's pond		200
Pinnacle, Smoak's pond		75
Pleasant Garden, Polecat Creek		75
Pollocksville, Clay Hill Branch		200
Prentiss, League Lake		1,000
Raeford, Beaver Dam Creek		200
Raleigh, Beaver Dam Fishing Club Pond		350
Milburnie Fishing Club Pond		350
Panther Branch Fishing Club Pond		350
Sorrell Branch		300
Sherwood Pond		200
Williams's pond		100
Ramseur, Brush Creek Pond		75
Deep River		225
Jordan's pond		75
Mill Stone Creek Pond		75
Patterson Pond		75
Red Springs, Graham Lake		300
Jobs Pond		200
Reidsville, Glady Creek Pond		75
Poplar Lake		150
Spring Branch Pond		75
Troublesome Pond		75
Rockford, Fanbush Pond		75
Rockingham, Bushby Branch Pond		100
Dockery Mill pond		100
Elerbe Springs Pond		100
Everett's pond		200
Harringtons Mill pond		200
Hinsons Mill pond		200
Lake Dockery		200
Rocky Point, North East Cape Fear River		300
Roseboro, Little Coharie Creek		300
Rosehill, Halls Mill pond		150
Rosindale, Clarks Mill pond		200
Rutherfordton, Brittains Mill Pond		100
Salisbury, Dutch Second Creek		75
Fishing Mill pond		75
Little Crane Creek		75
Medlin's pond		75
Turfflin Pond		75
Scotland Neck, Hyman Pond		150
Shelby, Broad River		300
Shoals, Davis Creek		75
Dills Creek		75
Halls Creek		75
Kittles Creek		75
Stow Creek Pond		75
Siloam, Ararat River		75
Southern Pines, Suburb Pond		100
Spero, Haskets Creek		75
Stanley, Dutchman Creek		200
South Fork River		300
Statesville, Back Creek		75
Big Rocky Creek		75
Buffalo Shoal Pond		75

DISTRIBUTION OF FISH AND FISH EGGS, BY LOCALITY AND SPECIES, FISCAL YEAR 1913—Continued.

LARGE-MOUTH BLACK BASS—Continued.

Disposition.	Fry.	Fingerlings, yearlings, and adults.
North Carolina—Continued.		
Statesville, Catawba River		75
Duck Creek		150
Elk Creek		150
Fifth Creek		150
Fourth Creek		75
Hunting Creek		75
Little Rocky Creek		150
Nesbitt Creek		75
Snow Creek		75
Third Creek		75
Town Creek		150
Stokesdale, Hilton's pond No. 2		75
Sunbury, Cross Mill Pond		250
Swans Station, Big Juniper Pond		200
Upper Little River		300
University, Double Spring Pond		100
Morgan's creek		150
New Hope Creek		200
Wade, Olive Park Pond		100
Wadesboro, Baucom's pond		100
Walnut Cove, Dan River		150
Wake Forest, Oneal's pond		100
Warsaw, Coopers Mill pond		200
Weldon, Roanoke River		750
Whiteville, Richardsons Mill pond		400
Wilbon, Burt's pond		175
Wilmington, Greenfield Lake		775
Winston-Salem, Jenkins's pond		75
Waterworks Pond		75
Ohio:		
Antwerp, Maumee River		275
Aurora, Harmons Pond		35
Blue Ash, Clarke's lake		100
Cambridge, Near Cut Lake		150
Wills Creek		300
Canfield, Lake Taylor		200
Cecil, Maumee River		550
Celina, Grand Reservoir		300
Chippewa Lake, Chippewa Lake		1,225
Cleveland, Mayfield Pond		200
Spring Pond		100
Columbus, Alumn Creek		300
Bass Lake		150
Big Walnut Creek		600
Esswein Lake		600
Little Walnut Creek		300
Spring Lake		600
Congress Lake, Congress Lake		450
Covington, Covington Mill pond		150
Painter Creek		150
Stillwater River		300
Dayton, Miami River		600
Eaton, Seven Mile Creek		300
Farmersville, Big Twin Creek		300
Findlay, Auglaize River, Blanchards Fork		70
Fort Jennings, Auglaize River		350
Fremont, Green Creek		100
Sandusky River		275
Geneva, Grand River		275
Georgetown, Moore Pond		100
Geauga Lake, Geauga Lake		275
Harpster, Lewis Lake		100

Disposition.	Fry.	Fingerlings, yearlings, and adults.
Ohio—Continued.		
Hillsboro, Clear Creek		100
Rocky Fork Creek		300
Hudson, Glass Pond		175
Kent, East Twin Lake		275
Lake Stewart		275
Lima, Rhodes Pond		150
Rimer Quarry Pond		100
Watkins Pond		150
Lorain, Anderson's pond		100
McCutchenville, Mohawk Lake		100
Mansfield, Clear Fork River, North Fork		150
Midland City, Gem Valley Pond		150
Millbury, Quarry Pond		100
Mount Blanchard, Blanchard River		275
Mount Orab, Sterling Pond		100
Napoleon, Maumee River		175
Oak Harbor, Portage River		275
Oakwood, Auglaize River		275
Okolona, Maumee River		275
Ontario, Vogel Lake		350
Palmyra, Mahoning River		525
Peninsula, Clear Lake		70
Crystal Pond		35
Ravenna, Muzzy Lake		200
Sandy Lake		200
Valedge Pond		100
Russells Point, Indian Lake		300
Lewistown Pond		150
Sandusky, Hoover Pond		175
Springfield, Cliff Lake		300
Little Miami River		300
Storms Station, Paint Creek		300
Sycamore, Honey Creek		275
Walton's pond		100
Tiffin, Lake Mohawk		275
Toledo, Silica Lake		275
Upper Sandusky, Sandusky River		275
Urbana, Brush Lake		150
Crane's pond		150
Long Pond		150
Wapakoneta, Auglaize River		300
Washington Court House, Rattlesnake River		300
Waynesburg, Sandy Creek and canal		350
Wellsville, Smith's pond		200
Youngstown, Crystal Lake		100
Pine Lake		300
Oklahoma:		
Ada, Lake Ada		200
Altus, City Reservoir		375
Ardmore, Bass Lake		200
Chickasaw Lake		450
City Lake		300
Dick Lake		250
Gorman Lake		300
Kirkpatrick Lake		300
Lorena Park Lake		150
Luna Lake		250
Miller Lake		200
Van Guilder Lake		300
Aylesworth, Madill-Durant Lake		300
Bartlesville, Silver Lake		400
Berwyn, Young Lake		300
Big Cabin, Rock Creek Lake		150
Bixby, Allen Lake		150

DISTRIBUTION OF FISH AND FISH EGGS, BY LOCALITY AND SPECIES, FISCAL YEAR 1913—Continued.

LARGE-MOUTH BLACK BASS—Continued.

Disposition.	Fry.	Fingerlings, yearlings, and adults.
Oklahoma—Continued.		
Brinkman, Lampert's pond		100
Bristow, Kelly Lake		100
Bunch, Long Foot Pond		300
Carnegie, Washita River		150
Casey, Maramec Pond		150
Maramec Lake		150
Castle, Davenport's pond		150
Chattanooga, Bowlby's pond		75
Chickasha, Jack Hollow Lake		100
Lake Lanier		100
Tony Lake		75
Chicotah, Sunnyslope Pond		150
Chouteau, Adkins' lake		150
Deaver Lake		150
Claremore, Humphreys Pond		300
Comanche, Impson's pond		75
Cordell, Miller's pond No. 2		150
Covington, Keller's pond		75
Coweta, Baker Pond		100
Crescent, Cedar Lake		150
Swains Pond		75
Custer, Fifer's pond		75
Davis, Brady Lake		100
Capps Lake		100
Cedar Grove Lake		100
Eaves Park Lake		150
Honey Grove Lake		100
Paynes Retreat Lake		100
Dewey, Willow Lake		100
Doby Springs, Bradford's pond		125
Duncan, Weaver Lake		150
El Reno, Bellany Lake		150
Cora Bell Lake		100
El Reno Rod and Gun Club Lake		150
Erick, Meadow Brook Dairy Pond		75
Eufaula, East Eufaula Lake		300
Piney Creek		300
Fallis, Lake Charles		300
Glencoe, Wills Lake		150
Gravette, Lucas & Yocom Pond		250
Guthrie, Ellison Lake		100
McCall Lake		100
Overtons Lake		100
Redingtons Lake		100
Spring Lake		100
Twin Lakes		100
Walkers Lake		100
Williams Lake		100
Hartshorne, Choctaw Lake		300
Lake Savage		300
Haskell, Cox Pond		150
Lake Concharty		150
O. K. Lake		150
Hugo, Krauter Lake		100
Kulli Chitto Lake		200
Indiahoma, Baldwin's pond		75
South Farm Pond		75
Lawton, Allison's pond		50
Bath Lake		150
Blue Beaver Creek		100
Gondola Lake		100
Lawtonka Lake		200
Lloyds Pond		150
Little Medicine Creek		150
Lexington, Conkling's pond No. 1		75
Oak Hill Pond		75
McAlester, Hardy's pond		100
Highlands Lake		100
Lake Talawanda		300
McAlester, McAlester Country Club Lake		250
Mountain Gap Lake		300
Wild Horse Lake		200
Mangum, Elm Spring Pond		150
Trotter's pond		150
Marietta, Horseshoe Pond		100
Kirkpatrick Lake		100
Rock Creek		150
Massey, Massey Pond		100
Milton, Wolf Creek		150
Moore, Kalivoda Lake		75
Mountain View, Jones Pond		75
Pecan Creek		150
Saddle Mountain Creek		150
Stinking Creek		150
Sugar Creek		150
Mulhall, Twenty-one Pond		50
Muskogee, Illinois River		500
Illinois River, Barren Fork		400
Mountain Creek		300
Silver Creek		300
Spring Valley Lake		300
New Castle, Haun's pond		75
Oklahoma City, Folly Lodge Lake		100
Houghton Lake		75
Waldons Lake		175
Okmulgee, Phillips Pond		100
Owasso, Owasso Lake		300
Pauls Valley, Thompson Lake		75
Perry, Perry Country Club pond		50
Prague, Erets Lake		450
Pryor, Fairview Lake		150
Midway Lake		300
Sulphur Creek		150
Whitaker Park Pond		150
Wolf Creek		150
Purcell, Crawford's pond		100
Randlett, Suters Lake		60
Red Fork, Lake Sue		300
Russet, White Pond		150
Sapulpa, Euchre Creek		200
Rock Creek		300
Seminole, Rock Pond		150
Shawnee, Lakeside Pond		200
Maud Lake		500
Spiro, Spiro Pond		350
Stillwater, Boomer Creek		150
Ritter Lake		150
Stillwater Reservoir		150
Yost Lake		450
Stratford, Demonstration Pond		150
Tulsa, Ketchum Lake		300
Owen Park Pond		300
Verden, Williams Lake		75
Vinita, Little Cabin Creek		300
Locust Creek		150
West Cabin Creek		300
White Oak Creek		300
Wagoner, Horseshoe Lake		150
Vann's lake		300
Wardsville, Triplet Lake No. 1		150
Waurika, Fletcher's pond		225
Wayne, Dulony's pond		75

DISTRIBUTION OF FISH AND FISH EGGS, BY LOCALITY AND SPECIES, FISCAL YEAR 1913—Continued.

LARGE-MOUTH BLACK BASS—Continued.

Disposition.	Fry.	Fingerlings, yearlings, and adults.
Oklahoma—Continued.		
Westville, Smith's pond		150
Wright, Holzman Lake		50
Wyandotte, Lost Creek		150
Yukon, Big Pond		75
Long Pond		75
Shelby's pond		75
Pennsylvania:		
Akron, Cocalico Creek		200
Arcola, Perkiomen Creek		110
Skippack Creek		110
Brandamoore, Brandywine Creek		220
Cambridge Springs, Edinboro Lake		80
Cedar Knoll, Brandywine Creek		220
Chambersburg, Conococheague Creek		20
Chester, Chester River		75
Crum Creek		75
Ridley Creek		75
Collegeville, Perkiomen Creek		110
Skippack Creek		110
Cossart, Newlins Mill pond		160
Pyle Dam		120
Doylestown, Mill Creek		110
Neshaminy Creek		220
Pine Run		110
Falls, Silver Lake		250
Susquehanna River		250
Fort Loudon, Conococheague Creek		150
Gardners, Conewago Creek		300
Gettysburg, March Creek		300
Goldsboro, Susquehanna River		250
Graters Ford, Perkiomen Creek		110
Skippack Creek		110
Greencastle, Conococheague Creek		20
West Conococheague Creek		20
Honey Brook, Brandywine Creek, East Branch		80
Brandywine Creek, West Branch		80
Hosensack, Hancock's pond		110
Hosensack Pond		100
Huntingdon, Raystown Branch		40
Icedale, Brandywine Creek		220
Indiana, Yellow Creek		300
Lancaster, Conestoga River		120
Meadville, Sugar Lake		80
Mechanicsburg, Conodoguinet Creek		40
Mercersburg, Conococheague Creek, West Branch		150
Mehoopany, Susquehanna River		540
Middleburg, Middle Creek		300
Mifflin, Tuscarora Creek		20
Monocacy, Monocacy Creek		70
Mount Holly Springs, Mountain Creek Pond		180
Mount Union, Aughwick Creek		80
Juniata River		120
Mount Wolf, Laurel Creek		250
Little Conewago Creek		250
Pennsylvania—Continued.		
Myerstown, Swatara Creek		20
Neshaminy Falls, Neshaminy Creek		180
New Oxford, Conewago Creek		300
Newton-Hamilton, Juniata River		20
Norristown, Schuykill River		110
Oaks, Skippack Creek		110
Orbisonia, Aughwick Creek		300
Black Log Creek		150
Shade Creek		150
Palm, Perkiomen Creek		220
Pequea, Pequea Creek		75
Susquehanna River		375
Philadelphia, Fairmount Park Aquarium		25
Phoenixville, French Creek		20
Schuykill River		100
Pittsburgh, Straub's pond		180
Point View, Juniata River, Frankstown Branch		20
Rahns, Perkiomen Creek		110
Skippack Creek		110
Reading, Maiden Creek		20
Muddy Creek		20
Northkill Creek		20
Tulpehocken Creek		20
Ryde, Juniata River		40
Sabula, Sabula Lake		300
Safe Harbor, Susquehanna River		75
St. Peters, French Creek		180
Scotland, Conococheague Creek		20
Shenks Ferry, Susquehanna River		75
Shirleysburg, Aughwick Creek		300
Spring City, Mill Pond		20
Sprogel's run		50
Stony Creek		50
Telford, Perkiomen Creek, Northeast Branch		180
Topton, Saucony Creek		110
Washington Borough, Susquehanna River		75
West Chester, Brandywine Creek		75
Winfield, Penn's creek		200
Wrightsville, Kreidler's creek		120
Susquehanna River		120
Wycombe, Neshaminy Creek		180
Yerkes, Perkiomen Creek		110
Skippack Creek		110
York, Beaver Creek		125
Bennett's creek		125
Bermuda Creek		125
Big Conewago Creek		125
Bull Run Creek		125
Cabin Creek		125
Codorus Creek		125
Codorus Creek, South Fork		125
Codorus Creek, West Fork		125
Conewago Creek		250
Fishing Creek		125
Fox Creek		125
Kreutz Creek		125
Little Conewago Creek		125
Ore Valley Pond		125
Otter Creek		125
Yorkhaven, Susquehanna River		500

DISTRIBUTION OF FISH AND FISH EGGS, BY LOCALITY AND SPECIES, FISCAL YEAR 1913—Continued.

LARGE-MOUTH BLACK BASS—Continued.

Disposition.	Fry.	Fingerlings, yearlings, and adults.
Rhode Island:		
Westerly, Paucatuck River		45
South Carolina:		
Florence, Muldraws Mill pond		1,750
Sumter, McGirt Mill Pond		500
South Dakota:		
Aberdeen, Lake Minneeho		90
Ardmore, Pease Lake		30
Belle Fourche, Diversion Dam		105
Castle Rock, Castle Rock Lake		70
Chamberlain, Martin's lake		70
Martin's pond		70
Gregory, Osler Lake		70
Hamill, Lake Wamblee		35
Philip, Buzzard Creek Pond		30
Haagenson's pond		75
Pierre, Binder's pond		75
Zigler's pond		75
Presho, Johnson's pond		15
Rapid City, Quincy Pond		75
West Channel Lake		45
Scenic, Cook's pond		30
Shoemaker, Willow Creek		35
Watertown, Lake Kampeska		660
Lake Pelican		2,740
Wewela, Newman's pond		35
Tennessee:		
Adams, Dillard's pond		150
Elk Fork Creek		150
Fort's ponds		450
Ashland City, Sycamore Creek		300
Bells, Booth's pond		100
Bethel Springs, Cude's pond		90
Buffalo Valley, Bate's pond		150
Chattanooga, Caldwell Pond		375
Hixon Lake		300
McCallie Lake		300
Clarksville, Davies Pond		150
Minnow Pond		150
Red River		300
Red River, Big West Fork		300
Red River, Little West Fork		300
Sunny Lake		150
Cleveland, Candies Creek		300
Hall's pond		150
Rainbow Lake		300
Wildwood Lake		150
Columbia, Duck River		300
Fountain Creek		300
Rutherford Creek		300
Cowan, Moore's pond		40
Decherd, Criswell's pond		40
Donelson, Massey's pond		150
Farner, Plumley Branch		150
Rock Creek Pond		150
Turtletown Creek		300
Fayetteville, Elk River		450
West Mulberry Creek		450
Franklin, Big Harpeth River		450
South Harpeth River		150
Gallatin, Rogan Pond		150
Graham, Garners Creek		150
Greenbrier, Red River, Sulphur Fork		150
Greenville, Lick Creek, Long Fork		200
Tennessee—Continued.		
Hampton Station, Darden's pond		150
Fortson's pond		150
Murphy's ponds		300
Winter's pond		150
Harriman, Emory River		225
Lakeview Lake		75
Watson's pond		75
Henry, Outing Lake		150
Hollow Rock, Railroad Pond		100
Huntland, Mingo Pond		150
Jasper, Town Creek		150
Jefferson City, Holston River		300
Kingston Springs, Brush Creek		200
Lawrenceburg, Shoal Creek		150
Shoal Creek, North Fork		150
Shoal Creek, South Fork		150
Lewisburg, Hill Pond		150
Lexington, Freestone Pond		100
Lookout Station, Lake Lookout		80
Loudon, Paint Rock Creek		300
Martel, Howard's pond		150
Martha, Wood's pond		150
Mitchellville, Gossett's pond		100
Road Pond		100
Round Pond		100
McKenzie, Clear Lake		300
Morrison, Barren Fork River		225
Mount Pleasant, Big Bigbee Creek		300
Sugar Creek, East Fork		150
Wilson's pond		150
Murfreesboro, Lake Excelsior		40
Stockird's pond		40
Nashville, Caney Fork River		500
Lake Alberta		150
Lake Beasley		200
Smith Fork River		500
New Market, Taylor's pond		100
New River, New River		225
Norma, New River		300
Normandy, Isham Pond		40
Nunnelly, Piney River		300
Oakdale, Emory River		150
Obion, Obion River		200
Orlinda, Rose's pond		150
Round Pond		150
Petersburg, Cane Creek		150
Pierce Station, Morris Pond		150
Powell, Silver Lake		150
Probst, Lost Creek		300
Pulaski, Richland Creek		450
Quebeck, Caney Fork Creek		150
Rockford, Little River		300
Rossville, Wolf River		90
Roland, Sparkman's pond		75
Sailors Rest, Yellow Creek		450
St. Bethlehem, Gun Sink Pond		150
Johnson's pond		150
Sparta, Blue Spring Creek		150
Town Creek		150
Springfield, Porter's pond		300
Sycamore Creek		450

DISTRIBUTION OF FISH AND FISH EGGS, BY LOCALITY AND SPECIES, FISCAL YEAR 1913—Continued.

LARGE-MOUTH BLACK BASS—Continued.

Disposition.	Fry.	Fingerlings, yearlings, and adults.
Tennessee—Continued.		
Trenton, Powell's pond		180
Walling, Henderson's pond		75
Wartrace, Duck River, Garrison Fork		120
Waverly, Big Richland Creek		200
Blue Creek		200
Hurricane Creek		300
Trace Creek		250
Wetmore, Prendergast Pond		300
White Bluff, Harpeth River		300
Turnbull Creek		250
Whitwell, Sequatchie River		150
Wildersville, Rush's pond		100
Spring Pond		100
Texas:		
Aguilares, Yates's pond		1,850
Alanreed, Meadow Pond		800
Alba, Hodges's ponds		1,500
Low's ponds		3,000
Outing Club Lake		2,500
Albany, Davis Pond		800
Newcomb Pond		655
Aledo, Trinity River, Clear Fork		2,400
Alpine, Thomas Pond		60
Alvin, Slataper's pond		1,000
Annona, English Lake		1,500
Asherton, Engel's pond		1,000
Sullivan's pond		200
Athens, Mills Ponds		2,000
Atlanta, Baucum's pond		1,000
Bivin's pond		1,000
Chandler's pond		1,000
Dunlap's pond		1,000
Westbrook's pond		125
Axtell, McGinty's lake		75
Bagwell, Dearth's pond		750
Bailey, Taylor's pond		800
Bangs, Rutledge's lake		500
Bardwell, Stovell's pond		2,500
Bassett, Stine's pond		750
Bastrop, Byar's pond		60
Bay City, Moore's pond		700
Beaumont, Neches River		450
Beckville, Crawford Mill pond		1,550
Bedias, Kerr & Bracewell's gin pond		1,500
Lee Lake		1,100
Belcherville, Benton's pond		125
Bellville, Clear Creek		4,500
Bettie, Brison's pond		3,000
Lindsey's pond		3,000
Big Wells, Vincent Lake		5,900
Birome, Birome Pond		1,500
Bishop, Bishop Lake		1,500
Blossom, Gray's pond		275
Oliver Pond		275
Read's pond		275
Blum, Brook's pond		500
Wade's ponds		1,000
Bonham, Bonham Cotton Mill Pond		1,500
Club Lake		3,000
Bon Weir, Stark Fish Pond		3,100
Bovina, Robbin's pond		650
Brady, Dutton's pond		100
White Lake		1,100
Brazos, Headquarters Lake		750
Brenham, Watson Lakes		1,150
Bronson, Spring Branch		900
Brownwood, Brownwood Lake		6,500
Camp's pond		675
Fairland Lake		1,200
Moore's lake		500

Disposition.	Fry.	Fingerlings, yearlings, and adults.
Texas—Continued.		
Bullard, Stripling's pond		380
Burton, Jaroszewsky's pond		868
Calvert, Beard's pond		90
Cameron, Cameron Pond		500
Carmine, Roemer's pond		800
Carthage, Foster's lake		900
Sycamore Lakes		1,000
Wall's pond		3,000
Center, Clear Spring Pond		2,250
Center Point, Medina River		4,000
Channing, Grapevine Creek		2,000
Running Water Creek		1,000
Chester, Willow Lake		1,000
Chillicothe, Hill Crest Pond		810
Christine, Lake Como		1,000
Clarksville, McCarver's pond		1,500
Red River Lake		5,250
Clint, Turner's lake		650
Coleman, Bachelor Prong Lake		1,560
Columbus, White's pond		800
Comfort, Guadalupe River		4,000
Concord, Thomason's pond		2,000
Cookville, Smith's lake		385
Coolidge, Keeling's pond		3,000
Corsicana, Benton Lake		1,000
Drane's pond		1,500
Fish Tank No. 1		3,000
Crockett, Bermuda Lake		1,000
Collin's pond		1,000
Woolly's pond		1,000
Crystal City, Moklatix Pond		100
Raymond Lake		2,740
Dallas, Country Club Lake		1,500
Meadow Pond		1,100
O'Neil's pond		1,500
Wah Hoo Club Lake		5,100
Del Rio, Devils River		200
Thomas Pond		100
Denison, Rod and Gun Club Lake		600
Shawnee Lake		8,500
Detroit, Angora Lake		750
Dooley Lake		1,500
Roger's pond		750
Scrap Pond		750
Whitner Pond		750
Dunlay, Medina Valley Pond		11,733
Eden, Brady Creek		1,000
Edgewood, Edgewood Club Lake		90
McClellan's pond		90
Melton Lake		1,100
Edna, Alligator Lake		520
Rice Canal		1,900
Ellinger, Holan's pond		1,500
Elm Mott, Club Lake		3,600
Elysian fields, Owen's pond		290
Emhouse, Reid Lake		2,500
Tinkle's pond		2,025
Encinal, Lenz's pond		1,600
Rettaber's pond		1,200
Ennis, Caldwell's pond		1,500
Cerf's pond		1,000
Ferris Lake		1,000
Pecan Grove Pond		1,000
Pound Lake		1,000
Sand Lake		3,500
Eustace, Lock Lake		1,000
Falfurrias, Jones's pond		600
La Tasa Lake		600
Brooks's pond		650
Ferris, Brick Company Pond		1,000
Floyd, Greenwade's pond		1,000

DISTRIBUTION OF FISH AND FISH EGGS, BY LOCALITY AND SPECIES, FISCAL YEAR 1913—Continued.

LARGE-MOUTH BLACK BASS—Continued.

Disposition.	Fry.	Fingerlings, yearlings, and adults.
Texas—Continued.		
Fluvanna, Browning's pond		400
Fort Stockton, Comanche Creek		2,400
Fort Worth, Fosdick's pond		3,000
Triplett's lake		3,000
Foukes Spur, Lake View		3,500
Fowlerton, Alligator Lake		3,000
Frio River		3,000
Franklin, Mosquito Pond		350
Frisco, Frisco Lake		2,200
Roger's pond		630
Gainesville, Bentley's lake		500
Garland, Dausye Lake		240
Lenard Creek		340
Garza, Bermuda Pond		100
Gates, Texas Company Lake		125
Germania, Osborne's pond		300
Giddings, Carmean's lake		1,100
Miertschin's pond		800
Gilmer, Bay Pond		175
Mont's pond		107
Gladewater, Tuttle's pond		1,000
Glidden, Clapp's lake		3,600
Deer Lake		2,700
Goodnight, Buffalo Ponds		200
Horse Pond		100
Spring Creek Pond		200
Gordon, Elmhurst Lake		1,500
Jamieson's pond		1,500
Miller's pond		1,500
Newton Pond		1,500
Providence Lake		1,500
Twin Lakes		1,500
Grand Prairie, Hughes's pond		215
Willow Pond		90
Grapeland, Elcaney Pond		2,500
Neel Pond		1,000
Grapevine, Grapevine Club Lake		1,500
Greenbrier, Beckham's pond		400
Duck Creek		5,250
Greenbrier Creek		1,010
Greenbrier Lake		400
Indian Creek		800
Mud Creek		400
Sand Pond		3,750
Williams Creek		2,250
Greenville, Camp's lake		500
Gresham, Sweet Gum Lake		800
Groveton, Southside Pond		6,000
Hallsburg, Clear Lake		2,500
Hawkins, Mill Creek		3,500
Hebronville, Edds Pond		1,250
Helmic, Railroad Pond		2,000
Henderson, Swinney Lake		1,000
Henrietta, Canyon Pond		1,000
Horseshoe Lake		2,000
Neville Lake		1,000
Honey Grove, Gauldin Lake		1,500
Hubbard, Bjurstrum's pond		380
Blue Pond		380
Lofgren's pond		380
Snag Pond		487
Hutchins, Dallas Club Lake		4,000
Jacksboro, Carroll's creek		8,500
Daugherty Lake		800
Knox Lake		1,475
Jacksonville, Black Pond		1,000
Boles Lake		1,400
Parrish Lake		90
Jonesville, Brown's pond		1,000
Kaufman, Allen's pond		1,100
Boykin's pond		1,000
Carlisle's pond		1,000
Texas—Continued.		
Kaufman, Crawfish Lake		525
Crown Lake		1,000
Gilmore Pond		1,000
Jones's lake		1,000
Lawson's pond No. 1		1,000
Mulkey's pond		1,000
Nash's pond No. 1		1,000
Nash's pond No. 2		1,000
Osborne Lake		1,000
Seine Lake		1,500
Kemp, Berry Lake		2,000
Clear Lake		2,000
Club Lake		2,500
Kemp Benny Lake		2,900
Long Lake		2,000
Kent, Tatum's spring		612
Kerens, Perry's pond		75
Kerrville, Barnett Pond		3,000
Beck's lake		1,500
Goat Creek		780
Gregory Lake		780
Guadalupe River, North Fork		1,000
Johnson Pond		790
Lackey Pond		3,000
Louis Lake		3,000
Kilgore, Hamilton's pond		1,130
Kosse, Denny Lake		1,000
La Mesa, Garland's pond		650
Lampasas, Campbell's pond		500
Collins's pond		500
Culver Pond No. 2		500
Laredo, McDermott Pond		2,000
Webb Lake		1,850
Leander, Faubion's pond		350
Leesburg, Turner Mill Pond		240
Lewisville, Heath Lake		180
Lexington, Beasley's pond		3,400
Lillian, Casteven's pond		1,500
Llano, Llano River		5,400
Lone Oak, Allmon's pond		600
Barnett Pond No. 1		700
Barnett Pond No. 2		1,500
Roberts's pond		700
Loraine, Davis Pond		300
Lott, Barlow Pond		1,800
Franzel's pond		1,800
Hunt Pond		1,700
Looka's pond		3,600
Lovelady, Jackson Lake		3,250
Loving Lake		800
Lubbock, Coleman Pond		650
Lufkin, Boynton Lake		2,000
Lyons, Bates Pond		800
Englemann's pond		800
Fahnert's pond		500
Hruska's pond		500
Oppermann's pond		800
Pivonka's pond No. 1		500
Pivonka's pond No. 2		500
Vest's pond		800
McDade, Bostic's pond		860
McKinney, Atkinson Creek		4,500
Burrus Pond		3,000
Doe Branch		2,300
McKinney Club Lake		3,000
McKinney's pond		2,700
Madisonville, Menefee's pond		3,000
Marion, Ebert's pond		575
Mart, Drinkard's pond		1,000
Megargel, Railway Pond		800

DISTRIBUTION OF FISH AND FISH EGGS, BY LOCALITY AND SPECIES, FISCAL YEAR 1913—Continued.

LARGE-MOUTH BLACK BASS—Continued.

Disposition.	Fry.	Fingerlings, yearlings, and adults.
Texas—Continued.		
Memphis, Lone Spring Pond		800
Meridian, Finley's pond		500
Mertzon, Shallow Well Lake		500
Mesquite, Duff Lake		1,100
Florence Lake		1,100
Marshall's lake		1,100
Mexia, Benton's pond		1,000
Redfield Pond		1,000
Miles, Willow Creek		500
Mineral Wells, Bluff Creek		2,600
Eagle Creek		2,400
Mineola, County Farm Pond		1,500
Glade Creek Pond		90
Holland Club Lake		620
Lloyd and Denton Pond		1,500
Mill Lake		1,500
Red Bud Lake		620
Russell's lake		1,500
Mount Calm, City Waterworks Pond		400
Gin Pond		400
Old Town Pond		185
Prairie Hill Lake		380
Mount Pleasant, Tennison's pond		3,000
Mount Selman, Brock Lake		500
Mount Vernon, Sharber's pond		800
Williams Lake		800
Naples, Pastime Pond		880
New Baden, Persimmon Pond		900
New Boston, Lumber Company Lake		2,000
New Braunfels, Bear Creek		2,400
Comal River		3,000
Guadalupe River		3,535
Newcastle, Chandler's pond		250
Lake Newcastle		250
Newsome, Bermuda Lake		1,000
Elwood Club Lake		1,250
Oake Lake		1,000
Nixon, Allen's pond		950
Campbell Pond		1,200
Nocona, Jarrard Pond		100
Onalaska, West Lumber Co.'s upper pond		3,000
Otto, Jund's pond		500
Paducah, Nash Pond		375
Paige, Behren's pond		100
Fox Pond		871
Kissmann's pond No. 1		800
Kissmann's pond No. 2		868
Laake's pond		100
Rhode's ponds		100
Ruehrmond's pond		800
Schellstede's pond		800
Paris, Bouvelard Farm Pond		1,500
Edzard's pond		750
Lake Rigi		275
Oneta Lake		750
Theilman Lake		600
Williams's pond No. 2		1,500
Perry, Eckert's pond		600
Pittsburg, Cole's pond		420
Efurd's pond		1,125
Ferndale Club Lake		1,250
Jackson's pond		1,250
Willow Pond		1,250
Plano, Bishop's pond		2,000
Plainview, Advance Lake		3,250
Lackey's pond		650
Little Gem Lake		1,950
Plateau, Akard's pond		612
Pledger, Matthews Lake		2,400
Point, Simmons Pond		800
Thornton's pond		325
Poteet, Martin's pond		1,000
Pritchett, Goffey's pond		75
Mathis Pond		1,500
Panky's pond		107
Purdon, Baker's pond		380
Moore's pond		175
Putnam, Wathen Lake		1,500
Retrieve, Lake Charlotte		600
Riesel, Klatt's pond		1,000
Krueger's pond		1,500
Sunsworth Lake		1,500
Turner's pond		1,500
Wehring's pond		1,000
Richards, Hamilton Pond		2,475
Rockdale, Alligator Lake		410
Clear Lake		1,000
Hicks Lake		1,000
Lee Pond		1,000
White Perch Club Lake		1,600
Rockwall, Leonard Lake		600
Willis Lake		1,250
Rogers, Kirksey's pond		500
Lake Odom		500
Rosebud, Gregory's pond		5,100
Stillwell's pond		5,400
Winkleman's pond		1,700
Rotan, Acs Pond		1,400
Bostick Pond		400
Forrester's pond		1,550
Loving Pond		1,830
Royse City, Bois D'Arc Lake		230
Royse City Lake		300
Sabinal, Frio River		500
Frio River, West Branch		500
Saginaw, Beall's pond No. 1		650
Beall's pond No. 2		650
Lake Wandry		1,300
San Antonio, Fest and McAskill Lake		600
Medina Valley Pond		5,867
Salado River		2,600
San Benito, Stegman Lake		2,500
San Marcos, San Marcos River		7,000
Santo, Ramsey Pond		500
Savoy, Large's pond		550
Seguin, Guadalupe River		4,400
Sherman, Evans Pond		1,100
Gunter's lake		1,000
Sierra Blanca, Hardwick Pond		650
Smithville, Lake Louise		60
Spring Branch		60
Willow Branch		5,000
Snyder, Fuller's pond		500
Huffman's pond		500
Thompson's pond		400
Spofford, Dutch Battle Ground Creek		500
West's pond		500
Streetman, Gilbert's pond		2,000
Sulphur Springs, Adams Pond		420
Eberta Lake		1,250
Railroad Pond		1,250
Swearingen, Beef Pond		600
Talpa, Laughlin Lake		500
Taylor, Hurta's pond		90
Temple, West Falls Pond		560
Tenaha, Lake Cliff		3,250

DISTRIBUTION OF FISH AND FISH EGGS, BY LOCALITY AND SPECIES, FISCAL YEAR 1913—Continued.

LARGE-MOUTH BLACK BASS—Continued.

Disposition.	Fry.	Fingerlings, yearlings, and adults.
Texas—Continued.		
Terrell, Adcock's pond		1,100
Breeden Pond		500
Butler's pond		1,100
Cariker Pond		1,000
Charlton's pond		550
Davis Pond		1,100
Griffith's lake		1,100
Griffith's pond		550
King Pond		1,000
Lewis Pond		500
Lockhead Pond		1,000
Lumkin's pond		1,100
McGinnis Pond		1,000
Morrow's pond		1,100
Noble's pond		1,100
Powell's pond		550
Raley & Gell Pond		550
Thorndale, Schroeder's pond		800
Thorndale Club Lake		90
Timpson, McLeroy's pond		25
Tioga, Roger's pond		2,100
Trinity, Manry Lake		1,000
Robb's lake		3,000
Skains Lake		1,500
Tyler, Holtzclaw's pond		3,000
Uvalde, Nueces River		2,750
Vernon, Castleberry's pond		800
Kell's pond		400
Long's pond		400
Waco, City Hall Fountain		200
Cooper's pond		185
Driskell Neall Lake		600
Waco Fish Pond		12,300
Waskom, Shady Pond		1,000
Waxahachie, Bermuda Lake		230
Webb, El Pato Pond		4,250
West, Elm Lake		300
Westville, Lumber Company Pond		1,000
Whitesboro, Whitesboro Lake		2,800
Wichita Falls, Lake Creek Lake		2,400
Waggoner's lake		1,600
Wills Point, Clear Lake		125
Wolfe City, Floyd's pond		800
Mill Pond		2,400
Warren's pond		800
Woodward, Woodward Creek		200
Woodward Lake No. 1		200
Woodward Lake No. 2		200
Yorktown, Hillside Pond		1,800
Vermont:		
Lyndonville, Chandler Pond		100
Virginia:		
Abingdon, Holston River, South Fork		800
Amelia, Crystal Lake		200
Barbours Creek, Craigs Creek		200
Bedford City, Nichols Lake		100
Bridgewater, Cooks Creek		150
Catron's Siding, Cripple Creek		500
Charlottesville, Moores Creek		150
Tudor Grove Pond		150
Covesville, Hardware Creek		300
Cullen, Blackstock's pond		200
Culpeper, Rappahannock River		400
Dixondale Wharf, Beaverdam Creek		100
Edinburg, Stoney Creek		200
Virginia—Continued.		
Elliston, Stiles's pond		100
Ewing, Indian Creek		100
Farmville, Edmunds's pond		100
Green Bay, Wing's pond		100
Griffith, Cowpasture River		550
Guinea, Copley's pond		80
Po River		180
Purks's pond		100
Sunnyside Pond		40
Ivor, Worrell's pond		150
Kincaid, Jackson River		550
Lawyers, Flat Creek		200
Lester Manor, Walkerton Pond		200
Wolverton Mill Pond		200
Lexington, Buffalo River		200
Lightfoot, Newman's pond		200
Marion, Spruce Creek		500
Newcastle, Craigs Creek		100
Johns Creek		300
Norfolk, Water Company Pond		100
North End, Fishing Bay Pond		125
Lake Grinels		125
Parr, Craig River		200
Petersburg, Burge's pond		600
Estes Pond		200
Haywood Mill pond		300
Jackson Pond		100
Kanes Mill pond		300
Old Town Creek Pond		500
Ruffins Mill pond		350
Potts Valley Junction, New River		200
Proffit, Miller's pond		100
Providence Forge, Mirror Lake		650
Providence Forge Pond		300
Randolph, Big Bluestone Creek		200
Richmond, Capitol Square Pond		50
Chesterfield Club Pond		200
Christian Mill pond		200
Diascond Pond		300
Forest Hill Park Lake		300
Fulton Club Pond		200
Harnish's pond		200
Johnson's pond		200
Joseph Bryan Pond		300
Licking Creek Pond		200
Loch Gregor Pond		100
Maddison Pond		200
Oklahoma Creek Pond		175
Vaidens Pond		300
Water View Pond		150
Yahleys Mill pond		200
Rock Castle, Dungeness Pond		100
Tilman's pond		100
Seneca, Seneca Creek		200
Spencer, South Mayo Creek		150
Stony Creek, Chappells Mill pond		350
Fishing Club Pond		200
Houle's pond		200

DISTRIBUTION OF FISH AND FISH EGGS, BY LOCALITY AND SPECIES, FISCAL YEAR 1913—Continued.

LARGE-MOUTH BLACK BASS—Continued.

Disposition.	Fry.	Fingerlings, yearlings, and adults.
Virginia—Continued.		
Stony Creek, Sapponey Mill pond		200
Suffolk, Lake Savage		400
Taylorstown, Catoctin Creek		250
Toano, Carlton's pond		175
Wheeler, Butchers Branch		500
Indian Creek		500
Winchester, Hillyard Pond		100
Windsor, Bracey's pond		300
Braswell's pond		300
Woods Lane, Travis's mill pond		100
Woodstock, Shenandoah River, North Fork		300
Washington:		
Almira, Boundary Lake		75
Anacortes, Hummels Lake		80
Boyds, Lost Lake		80
Bryant, Sunday Lake		40
Granite Falls, Wall Lake		40
Marble, Lake Maria		40
Oroville, Hershberger Lakes		150
Republic, Mud Lake		40
Swan Lake		40
Spokane, Silver Lake		80
Stanwood, Lake Ketchum		80
Winona, Big Cove Lake		75
West Virginia:		
Albright, Cheat River		120
Big Creek, Guyandotte River		400
Blue Creek, Elk River		500
Buckhannon, Buckhannon River		400
Charleston, Elk River		150
Davy, Indian Creek		300
Guyandotte River, Clear Fork		300
Elkins, Tygarts Valley River		880
Elm Grove, Big Wheeling Creek		300
Fairmont, Tygarts Valley River		300
Glendon, Birch River		400
Grafton, Tygarts Valley River		160
Great Cacapon, Great Cacapon River		1,300
Jacksonburg, Fishing Creek, South Fork		380
Kendalia, Blue Creek		400
Keyser, Pattersons Creek		75
Sanders's pond		300
Martinsburg, Back Creek		500
Opequon Creek		700
Mill Creek, Tygarts Valley River		400
Moorefield, Potomac River, South Branch		2,125
Morgantown, Cheat River		120
Dunkard Creek		50
Monongahela River		240
Moundsville, Fish Creek		300
Mullens, Barker's creek		300
Guyandotte River		500
Guyandotte River, Slab Fork		400
New Martinsville, Big Fishing Creek		80
Owensport, Little Kanawha River		200
Parkersburg, Little Kanawha River		220
Paw Paw, Potomac River		240
West Virginia—Continued.		
Pine Grove, Fishing Creek, North Fork		120
Porters Falls, Fishing Creek		300
Romney, Potomac River, South Branch		885
Ronceverte, Greenbrier River		880
St. Albans, Coal River		100
Shepherdstown, Potomac River		1,600
Sistersville, Middle Island Creek		80
Sitlington, Sitlington Creek		880
Terra Alta, Lake Terra Alta		75
Webster Springs, Elk River		320
Wheeling, Fish Creek		300
State Fair Aquarium		2
White Sulphur, Greenbrier River		240
Williamson, Tug River		400
Wisconsin:		
Antioch, Bebor's lake		175
Athelstane, Elbow Lake		250
Blair, Trempealeau Pond		300
Campbellsport, Forest Lake		350
Coloma, Crystal Lake		175
Pleasant Lake		175
Wood Lake		175
Cusson, Booher Lake		100
Devils Lake, Devils Lake		350
Eland Junction, Norrie Lake		850
Elkhart, Crystal Lake		350
Fairchild, Beaver Creek		200
Fond du Lac, Lake de Nevue		350
Hackley, Big Twin Lake		250
Lake Helen		125
Little Bass Lake		300
Little Twin Lake		250
Hancock, Fish Lake		350
Hartford, Pike Lake		350
Hatfield, Lake Arbutus		400
Independence, Big Elk Creek		100
Bugle Lake		100
Lower Elk Creek		100
Trempeleau River		300
Iron River, Armstrong Lake		125
Big Angus Lake		125
Bismarck Lake		125
Bladder Lake		125
Camp Four Lake		125
Camp Twenty Lake		125
Crow Lake		125
Eagle Lake		125
Finger Lake		125
Fire Lake		125
Hart Lake		125
Iron Lake		125
Little Angus Lake		125
Lost Lake		125
Moon Lake		125
Mud Lake		125
Pine Lake		125
La Crosse, Blacksnake Creek		200
Lake Beulah, Lake Beulah		350
Laona, Birch Lake		175
Langer Lake		275
Rat Lake		300
Silver Lake		175
Manitowoc, English Lake		175
Gass Lake		175

DISTRIBUTION OF FISH AND FISH EGGS, BY LOCALITY AND SPECIES, FISCAL YEAR 1913—Continued.

LARGE-MOUTH BLACK BASS—Continued.

Disposition.	Fry.	Fingerlings, yearlings, and adults.
Wisconsin—Continued.		
Manitowoc, Gatemans Lake		175
Glomsky's lake		175
Harp Lake		175
Hartlaub's lake		175
Hemptons Lake		175
Kastbaum's lake		175
Schisel's lake		175
Mauston, Lemonweir Mill Pond		175
Lemonweir River		175
Mauston Mill Pond		175
Mellen, English Lake		90
Mineral Lake		90
Merton, Lake Keesus		350
North Lake, North Lake		350
Okauchee, Okauchee Lake		525
Pelican, Pelican Lake		300
Plainfield, Fish Lake		175
Gilbert Lake		175
Koosle Lake		175
Lake Huron		175
Long Lake		175
Pine Lake		175
Random Lake, Random Lake		350
Sauk City, Koenigs Mill Pond		300
Schleisingerville, Cedar Lake		350
Sheboygan Falls, Gerbers Lake		350
Jetzers Lake		350
Spring Green, Wisconsin River		400
Spring Lake, Spring Lake		175
State Line, Bass Lake		300
Birch Lake		125
Crystal Lake		125
Lac Vieux Desert Lake		300
Pot Fish Lake		125
Stevens Point, Big Plover River		350
Rocky Run		175
Wisconsin River		525
Sturgeon Bay, Sturgeon Bay		525
Three Lakes, Big Fork Lake		125
Big Stone Lake		125
Butternut Lake		125
Cook Lake		125
Elm Lake		125
Island Lake		125
Wisconsin—Continued.		
Three Lakes, Long Lake		250
Medicine Lake		125
One Stone Lake		125
Range Line Lake		125
Spirit Lake		125
Town Line Lake		125
Tomah, Water Mill Pond		350
Van Ostand, Edith Lake		250
Wabeno, Buck Lake		300
Deer Lake		300
East Branch Lake		300
Jungle Lake		175
Slogenhoff Lake		300
Warrens, Razins Pond		400
Warrens Pond		400
Waupaca, Mirror and Shadow Lakes		350
Whitewater, Whitewater Lake		350
Wonewoc, Alcott Pond		175
Baraboo River		175
Baraboo River, West Branch		175
Castle Rock Pond		175
Crawfish Pond		175
Horseshoe Pond		175
Mill Pond		175
North Branch		175
Peters's pond		175
Rodgers Pond		175
Roehling's pond		175
Tank Pond		175
Timber Lake		175
West's pond		175
Wolfenden's pond		175
Wyoming:		
Casper, Casper Storage Reservoir		45
Hat Six Lake		30
Gillette, Lake De Smet		60
Glendo, North Platte River		30
Pine Bluff, Little Moon Lake		30
Rawlins, North Brown Canon Lake		30
South Brown Canon Lake		60
Sheridan, Dinwiddie Lake		40
Total[a]	26,250	1,231,052

[a] Lost in transit, 1,250 fry and 3,908 fingerlings.

SUNFISH (BREAM).

Disposition.	Fingerlings, yearlings, and adults.
Alabama:	
Altoona, Durham Spring Pond No. 2	100
Hurst's pond No. 1	100
Hurst's pond No. 2	100
Andalusia, Knox Pond	900
Anniston, Jelk's pond	75
Johnson's pond	150
Lake Keifer	150
Weatherly Pond	350
Alabama—Continued.	
Bessemer, West Lake	180
Birmingham, Brewster's lake	75
Feeneker's pond	600
Scott's branch	900
Carrollton, Bonner Mill Pond	200
Coalfire Creek	200
Lubbubb Creek	200
Centerville, Spring Hill Pond	400

DISTRIBUTION OF FISH AND FISH EGGS, BY LOCALITY AND SPECIES, FISCAL YEAR 1913—Continued.

SUNFISH (BREAM)—Continued.

Disposition.	Fingerlings, yearlings, and adults.
Alabama—Continued.	
Clayton, Bickley's pond	250
Fenn's pond	150
Fillingim's pond	150
Comer, Holly Creek	600
Cuba, McGowen's pond	250
Cullman, Brogden River	75
Cossey's pond	300
Graham's pond	75
Demopolis, Cement Company Pond	900
Elamville, Shepard Pond	150
Eufaula, Guice Lake	200
Wilson Pond	150
Eutaw, Kings Pond	400
Fayette, Mount Pleasant Pond	900
White's pond	400
Fort Payne, Crystal Lake	225
Sauty Creek	225
Town Creek	225
Gadsden, Big Canoe Creek	600
Greensboro, Lavender's pond	600
Ryan's pond	600
Greenville, Andress pond	300
Pine Barren Creek	450
Sirmons Mill pond	450
Thagard's pond	300
Haleyville, Bohannon Pond	600
Hartselle, Pike Road Pond	900
Huntsville, Farmer's lake	75
Jasper, Black Water Pond	3,000
Livingston, Hunter's pond No. 1	600
Hunter's pond No. 2	900
Millbrook, Young's pond	200
Montgomery, Hallonquist Lake	300
Howard's lake	300
Oneonta, Sand Lake	150
Opp, Benton's pond	450
Ozark, Mixson's pond	150
Phil Campbell, Dunkin's pond	300
Shirey's pond	900
Phoenix, Harden's lake	40
Russellville, Roberson Pond	900
Sanie, Margaret Lake	475
Seale, Dudley's pond	600
Speigner, Shelton Spring Pond	500
Stevenson, Stevenson Cotton Mill pond	900
Tanner, Peek's pond	600
Union Springs, Cope's pond	100
Veto, Hodge's pond	750
Arkansas:	
Alma, Big Clear Creek	400
Brentwood, Brown's pond	400
Cushman, Cushman Lake	250
Hatfield, Martin's pond	100
Little Rock, Pinehurst Lake	275
McKinney, Fern Springs Pond	100
Mabelvale, Thompson's pond	275
Mammoth Springs, Bellamy's pond	75
Mansfield, Brickyard Pond	550
Many Islands, Spring River	25
Marked Tree, St. Francis River	6,248
Monticello, McCandless Pond	100
Newport, Newport Lake	475
Warren, Town Branch	100
Florida:	
High Springs, Blue Pond	100
Jacksonville, Solace Lake	100
Monticello, Wolf Pond	100
Newberry, Cheves Pond	100
Santos, Lake Madonna	200
Tallahassee, Black Water Lake	60
Theressa, Alligator Pond	100

Disposition.	Fingerlings, yearlings, and adults.
Georgia:	
Allapaha, Baker's pond	150
Sherrod Mill pond	200
Arlington, Eunice Lake	75
Harrison Lake	100
Atlanta, East Lake	750
Ricket's pond	25
Silver Lake	300
Whiteman's pond	50
Zimmer's pond	1,140
Augusta, Hammond Mill pond	100
I. A. C. Reservoir	200
Avera, Long Branch	100
Bainbridge, Batteau Pond	300
Four Mile Pond	300
Ball Ground, Robert's pond	50
Bemiss, Beaverdam Pond	200
Box Springs, Lake Samoki	300
Bremen, Little River	250
Buena Vista, Hornady's pond	200
Shoal Creek Pond	200
Tyler's lake	100
Bullochville, Routon's pond	35
Cairo, Blackshear Pond	150
Carrollton, Davis Pond	50
Cave Springs, Connors Pond	150
Cedartown, Hick's pond	50
Chatsworth, Holly Creek	700
Chickamauga, Arnold's pond	100
Wellborn's pond	100
Collins, Powell's pond	100
Columbus, Ram Pond	200
Cross Keys, Brookhaven Lake	600
Cusseta, Gordy's pond	200
Log Cabin Pond	100
Cuthbert, Bridge's pond	50
Ellis Mill pond	150
Danville, White's pond	100
Dawson, Lee's pond	25
Douglas, McClellan Pond	100
Vicker's pond	400
Fayetteville, Bennetts Mill pond	300
Whitewater Pond	300
Fort Gaines, Harrisons Mill pond	175
Graysville, Chickamauga Creek	175
Greenville, McGehee's pond	50
Terrell's pond	100
Helena, Gum Swamp Creek	75
Hollysprings, Howell's pond	25
Jackson, Ocmulgee Lake	125
Lady Lake, Cup Lake	200
Lizella, Newberry's pond	100
Manassas, Sapp's pond	100
Marietta, Chamberlain Lake	25
Mayfield, Cason's pond	100
Lake George	100
Long Creek	100
Menlo, Lawrence Pond	150
Polk's pond	50
Monroe, East Lake	300
North Lake	300
Norcross, Lake Hoyle	150
Ochlocknee, Bay Pond	175
Beverly's pond	100
Ohoopee, Hall's pond	100
Omaha, Heard's pond	100
Osierfield, Dicksons Mill pond	150
Pelham, Budgass Pond	100
Waid Pond	100
Perry, Aultman's pond	40
Quitman, Lucas Pond	200
Ramhurst, Walley's pond	125
Renfroes, Holloman's pond	100

DISTRIBUTION OF FISH AND FISH EGGS, BY LOCALITY AND SPECIES, FISCAL YEAR 1913—Continued.

SUNFISH (BREAM)—Continued.

Disposition.	Fingerlings, yearlings, and adults.
Georgia—Continued.	
Rome, De Sota Park Lake	150
Roswell, Oliver's pond	100
Sparks, Gedden's pond	140
Summerville, Davis Fish Pond	50
Sylvester, Chapman's pond	100
Jernigan Pond	100
Talbotton, Barksdale Pond	100
Jordan's pond	100
Talking Rock, Hamrick's pond	25
Teloga, Sitton's pond	150
Thomasville, Magnolia Lake	500
Smith's lake	150
Tunnell Hill, Catoosa Fishing Club Lake	175
Union City, Silver Lake	35
Valdosta, Hammock Lake	400
Vienna, Lewis Pond	100
Warrenton, Harris Pond	200
Willacoochee, Haskin's pond	100
Illinois:	
Burksville, Coday Pond	100
Colfax, Gillan's pond	100
Crystal Lake, Crystal Lake	625
Decatur, Decatur Club Lake	3,050
Golconda, Clark's pond	200
Herrin, Childress Pond	100
Hinsdale, Salt Creek	200
Hunt City, Bowman's pond	100
Marshall, Heath's pond	100
Meredosia, Illinois River	450
Meredosia Bay	1,000
Mitchell, Long Lake	1,000
Momence, Kankakee River	300
Munster, Swift's pond	200
Tamaroa, Marshalek's pond	150
Taylorville, Park Lake	300
Watseka, Iroquois River	200
Indiana:	
Bass Lake Junction, Bass Lake	500
Batesville, Crystal Pond	100
Evansville, Davidson's pond	100
Fairmount, Hill's pond	100
Scott's pond	100
Fremont, Lake George	400
Hazleton, Fairview pond	100
Topeka, Atwood Lake	300
Dallas Lake	300
Hockenburg Lake	300
Long Lake	300
Messic Lake	300
Washington, Nixon's pond	100
Iowa:	
Bellevue, Mississippi River	850
Chester, upper Iowa River	800
Donnellson, Klingler Pond	100
Dunlap, Roberts Lake	100
Harlan, Jorgenson's pond	100
Lime Springs, upper Iowa River	1,000
New London, Sunapee Lake	300
Oxford, Harker's pond	200
South Amana, Shady Lawn Lake	100
Wapello, Heins's pond	100
Waterloo, Cedar River	150
Kansas:	
Baxter Springs, Ransom's lake	400
Bonner Springs, McKeown Lake	400
Kingman, Shady Grove Lake	300
Spring Pond	200
Mound City, Thornes Reserve pond	400
Kentucky:	
Anchorage, Demaree's pond	100
Homewood Pond	100
Bloomfield, Sugar Valley Pond	100

Disposition.	Fingerlings, yearlings, and adults.
Kentucky—Continued.	
Buechel, Snarenberger's pond	100
Covington, Geisen's pond	100
Crofton, Crofton Lake	200
Devon, Middendorf's pond	100
Eminence, Smith's pond	100
Franklin, Milliken's pond	100
Georgetown, Pullen's pond	100
Hodgenville, Holland's pond	100
Jetts, Henton's pond No. 1	100
Henton's pond No. 2	100
La Grange, Bourne's pond	100
Lawrenceburg, Carroll's pond	200
Leathers's pond	100
Maple Ridge Pond	100
Lebanon, Hillhurst Pond	100
Livia, Collins's pond	100
Louisville, Lake Lansdowne	400
Paris, Pryor Pond	100
Pulaski, Mound Lake	100
Sebree, Rolands Mill pond	100
Sparta, Eagle Pond	100
Tip Top, Cedar Grove Pond	100
Trenton, Williams's pond	100
Tyrone, Lillard's lake	100
Riverside Pond	100
Louisiana:	
Covington, Ellis's pond	900
Gretna, Fos Canal	1,800
McManus, Colony Lawn Lake	900
Maryland:	
Great Falls, Potomac River	11,000
Woodsboro, Meadow Pond	75
Massachusetts:	
Boston, Lily Pond	100
Michigan:	
Clarkston, Parkinson's lake	300
Clyde, Fish Lake	300
Davisburg, Long Lake	300
Edwardsburg, Miller Pond	300
Farmington, Gibson Lake	150
Minnesota:	
Caledonia, Schicks Lake	350
Hokah, Pettibone Park Lake	500
Homer, Mississippi River	3,500
Mississippi:	
Ackerman, Woodward's pond	450
Yokanookany Pond	900
Amory, Brown's pond	600
Artesia, Guerry's pond	300
Batesville, Maxey's pond	300
Bay Springs, Eatahoma Pond	1,200
Blue Mountain, Mountain View Lake	400
Bolton, Brownsville Pond	450
Gaddis's pond	450
Booneville, Burton's pond	900
Brandon, Stubblefield's pond	900
Canton, Big Lake	300
Oil Mill Pond	900
Coldwater, Progress Farm Pond	300
Crawford, Blue Pond	300
Isle Pond	300
Ledbetter's pond	300
Fayette, Krauss Ponds	300
Guntown, Webb Pond	500
Jackson, Ashland Pond	300
Laurel, Euberson Lake	1,200
Lexington, Ashley's lake	300
Meridian, Brawner Pond	300
Lauderdale Lake	300
Lyle's pond	300
New Pond	450
South Lake	900
Thames Lake	300

DISTRIBUTION OF FISH AND FISH EGGS, BY LOCALITY AND SPECIES, FISCAL YEAR 1913—Continued.

SUNFISH (BREAM)—Continued.

Disposition.	Fingerlings, yearlings, and adults.
Mississippi—Continued.	
Meridian, Weems's lake	300
Neshoba, Holley's pond	300
Pullin's pond	300
New Albany, Connor's pond	300
Taylor's pond	900
Thompson's pond	900
Newton, Byrd's pond	400
Osborn, Montgomery Pond	300
Pachuta, Phalti Lake No. 2	1,000
Picayune, Puyper's pond	400
Pontotoc, Brown Lake	300
Prentiss, Polk and McPhell Pond	300
Raymond, Spangler's pond	900
Red Banks, Woods's pond	900
Ripley, Nance's pond No. 2	400
Shuqualak, Mack's pond	1,200
Starkville, Montgomery's pond	300
Owens's pond No. 1	300
Owens's pond No. 2	300
Smyrna Pond	450
Stonington, Stonington Pond	300
Strong, Hanging Kettle Creek	900
Watson's pond	900
Sumner, Cassity Creek	150
Tupelo, Beech Pond	450
King Creek	4,000
Park Lake	9,500
Ritter's pond	700
Town Creek	3,500
Trapp's pond	500
Union, Walters's pond	300
Vaiden, Lowe's pond	300
Verna, Dunaway's pond	900
Vicksburg, Schlottman's pond	300
Vossburg, Donald's pond	450
Waynesboro, Savannah Pond	300
Weir, Bywyah Pond	450
Wesson, Austin's pond	300
Beauregard Pond	300
Emery Lake	300
Williams's pond	300
West Point, Yeates's pond	300
Missouri:	
Bunceton, Castleman's branch	500
Layton's creek	500
Chilhowie, Osborn's pond	400
Exeter, Cliff Ranch Pond	400
Cole's pond	400
McMurtle Run	400
Owl Creek	800
Grandview, Lake Claire	400
Lebanon, Oak Pond	300
Lowry City, Walker's pond	400
Neosho, Hearrell Branch	918
Hickory Creek	7,500
Parkville, Emily Heights Pond	400
Pleasant Hill, Kellogg Lake	685
Willow Lake	400
Potosi, Quaker Pond	300
Rolla, Little Beaver Creek	500
North Mill Creek	800
Wildcat Creek	500
Vermont, Harned's lake	300
Wayne, Bradley Mill Pond	400
Montana:	
Kalispel, Emmert Lake	250
Nebraska:	
Crete, Plachy's pond	100
New Jersey:	
Woodbury, Woodbury Creek Pond	125
New York:	
Bay Shore, Brightwater Lakes	125
Ithaca, Experimental Ponds	150
New York—Continued.	
Petersburg, Taconee Lake	600
Riverdale, Steiner Lake	125
North Carolina:	
Davidson, Linden Pond	100
Dunn, Jernigan's pond	200
Forest City, McKinney's pond	50
Fremont, Yelverton's pond	270
Gela, Lake Caldwell	200
Glen Alpine, Landreau's pond	200
Harrisburg, Rocky River Pond	50
Henderson, Sandy Creek	600
Hendersonville, Laurelia Lily Pond	200
Kenly, Boswell Pond	400
Kinston, Webb's pond	90
Littleton, Johnstons Mill pond	200
Panacea Pond	200
Ryders Ponds	200
Maxton, Lumber River	50
Monroe, Belk's pond	50
Morven, McLaurin's pond	50
Mount Gilead, Stanback's pond	50
North Wilkesboro, Mulberry Creek	300
Prentiss, League Lake	100
Raleigh, Baker Pond	270
Beaver Dam Pond	270
Roaring River, Hose Creek	100
Rockingham, Everett Pond	50
Rosindale, Clark Mill pond	200
Rural Hall, Stauber's pond	100
Sanford, Haky's pond	90
Swann Station, Barbecue Creek	270
Wadesboro, Bancom Mill pond	50
Marshall's pond	50
Warsaw, Coopers Mill Pond	270
Weldon, Roanoke River	500
Winston-Salem, Hege's lake	100
Holton's pond	100
Zebulon, Chamblee Pond No. 1	90
Chamblee Pond No. 2	90
Robertson's pond	90
Ohio:	
Bridgeport, Kennedy's pond	100
Cambridge, Wills Creek	100
Canfield, Mahoning Lake	100
Clinton, Luna Lake	100
Congress Lake, Congress Lake	500
Edison, Whetstone River, East Branch	260
Kent, West Twin Lake	200
Ravenna, Forest Pond	100
Oak Grove Pond	100
Shady Brook Pond	100
St. Clairsville, Puritan Pond	100
Sycamore, Sandusky River	200
Waynesburg, Sandy Creek and Canal	500
Youngstown, Lake Ellen	100
Lake Hamilton	400
Pine Lake	400
Oklahoma:	
Canton, Billing's pond	100
Doby Springs, Bradford's pond	300
Durant, Williams's pond	200
Kiowa, Wilson's pond	100
Lawton, Lake Lawtonka	300
Oklahoma City, Bisbee's pond	100
Steanson's pond	200
Sapulpa, Butcher's pond	250
Rock Creek	250
Wanette, Meinert's pond	300
Wright Station, Pot Hollow Pond	100
Oregon:	
Albany, Channel Lake	300
Halsey, Muddy Creek	300
Klamath Falls, Lost River	150

DISTRIBUTION OF FISH AND FISH EGGS, BY LOCALITY AND SPECIES, FISCAL YEAR 1913—Continued.

SUNFISH (BREAM)—Continued.

Disposition.	Fingerlings, yearlings, and adults.
Pennsylvania:	
Birdell, Brandywine Creek	100
Bowers, Sacony Creek	200
Cossart, Pyle's dam	200
Icedale, Brandywine Creek	100
Lancaster, Pequea Creek	200
Lebanon, Conewago Lake	100
Light Lake	200
Mount Gretna Lake	100
Pequea, Susquehanna River	200
Philadelphia, Fairmount Park Aquarium	300
Reading, Maiden Creek	300
Tulpehocken Creek	200
Rowland, Lackawaxen River	200
Lake Teedyuscung	200
Little Tink Pond	200
Wescolang Lake	200
Stroudsburg, Lehman Lake	200
Tacony, Shuman's pond	100
West Chester, Brandywine Creek	100
South Carolina:	
Aiken, Old Ford Pond	200
Thorpe's pond	200
Alcolu, Slowdens Mill pond	400
Angelus, Knight's pond	340
Bethune, Johnson's pond	200
Blaney, Kirkland Pond	400
Chappells, Webb's pond	200
Columbia, Adams Mill pond	400
Congaree, Rain Pond	200
Donalds, Oak Pond	100
Edmund, Thrasher Pond	400
Fountain Inn, Lake Jean	125
Gaffney, Little's pond	100
Greenville, Catawba Creek	100
Hartsville, Boggy Swamp Pond	330
Lawton's pond	330
Kershaw, Kirkley's pond	200
Laurens, Bolt Branch	125
Monetta, Jordan's pond	200
Neeses, Williams's pond	200
Orangeburg, Great Branch Pond	400
Otranto, Goose Creek Lake	400
Pomaria, Aull's pond	200
Crims Creek	200
Koon's pond	200
Salley, Dean Pond	200
Salley's pond	200
Sawyer's pond	200
Seivern, Gunter's pond	200
Summerville, Flood Gate Pond	200
Sumter, Pocalla Springs Pond	100
Swansea, Sandy Run	100
Wagener, Horsey's pond	200
Walhalla, Oconee Creek	100
Westminister, Bruner's pond	100
Westville, Gaskin's pond	200
Winnsboro, Duck Pond	200
South Dakota:	
Komer, Koenig's pond	100
Oral, Graves's pond	100
Watertown, Lake Kampesca	1,800
Tennessee:	
Austral, Lake Pleasant	100
Bartlett, Hood's pond	100
Bethpage, Beechwood Pond	150
Cohutta, Mitchell's pond	100
Dutch, Coffman's pond	100
Erwin, Banner's pond	100
Franklin, McDaniel's pond	100
Greenback, Kidd's pond	100
Greenville, Bowser's pond	100
High Point Lake	350
Tennessee—Continued.	
Hunter, May's run	200
Knoxville, Limestone Lake	100
Tindell's pond	100
Wayland's pond	100
Lookout Station, Lake Lookout	700
Manchester, Big Duck River	400
Noeton, Hipshire's pond	100
Orlinda, Kelly's pond	150
Paris, L. & N. R. R. Dam	100
Shouns, Freestone Pond	100
Somerville, Albright's pond	80
Tennessee City, Lake View	100
Texas:	
Atlanta, Chamblee's pond	100
Beaumont, Garrison Lake	50
Dallas, Joyce Pond	100
Denison, Iron Ore Creek	100
Shawnee Creek	100
Egan, Moore's pond	100
Fate, McLendon's pond	100
Garrison, Gum Pond	50
Henderson, Bessie Beall Pond	100
Hillsboro, Pott's pond	100
Houston, Bering's pond	100
Lindale, Morris Pond	200
Stewart Lake	100
Marshall, Bonita Lake	150
Bream Fish Lake	150
Mineola, Andrew's lake	150
Cochrane's lake	150
Falkner's lake	150
Gaston Lake	150
Grassy Lake	150
Greenville Railroad Pond	150
Lander's lake	150
Mansell's lake	150
Patten's lake	150
Ponta, Rice Pond	100
San Antonio, Dullnig Lakes	200
West Lake	25
Willson Lake	25
Temple, Temple Ice Pond	100
Terrell, Allen's pond No. 1	100
Allen's pond No. 2	100
Bass Pond	100
Boat Lake	100
Campbell Pond	100
Cartwright's pond	100
City Park Lake	200
Corley's lake	100
Cowles Lake	100
Darst Pond	100
Hamilton's lake	100
Hopkins' pond	100
Horn Pond	100
Jim's pond	100
Levy Pond	100
Lowrie Pond	100
Overton's pond	100
Pace's pond	100
Porter's pond	100
Thompson's pond	100
Warren's pond	100
Weatherford Lake	100
Weatherford Pond	100
Tyler, Brumby Lake	250
Burleson Lake	250
Chinquapin Lake	250
Hamilton Mill pond	250
Hill's lake	250
Hitts Mill pond	250
Saline Creek	250
Waco, Fountain Lake	100

DISTRIBUTION OF FISH AND FISH EGGS, BY LOCALITY AND SPECIES, FISCAL YEAR 1913—Continued.

SUNFISH—Continued.

Disposition.	Fingerlings, yearlings, and adults.	Disposition.	Fingerlings, yearlings, and adults.
Texas—Continued.		Washington:	
Weimar, Pecan Pond	50	Spokane, Gravelly Lake	150
Zavalla, Rocky Head Pond	50	Williams' lake	300
Virginia:		Tacoma, American Lake	150
Burnley, Cason's pond	200	Steilacoom Lake	150
Chula, Carter's pond	100	West Virginia:	
Coeburn, Grizzle & Deel pond	100	Fairmont, Tygart Valley River	100
Drakes Branch, Eggleston's pond	100	Liverpool, Deer Lick Pond	100
Maurertown, Shenandoah River, North Branch	300	Romney, Haines' pond	200
Midlothian, Ittner's pond	200	Terra Alta, Slaubaugh's pond	200
Montpelier, DuPont's pond	12	Webster Springs, Gregory's pond	150
Newcastle, Given's pond	100	Wisconsin:	
Norfolk, Hermitage Ponds	200	La Crosse, French Lake	300
Smithfield, Vellines Pond	100	Rice Lake	300
Staunton, Edgerock Lake	100	Zeisler's lake	300
Wytheville, Valley View Pond	100	Total[a]	203,623

PIKE AND PICKEREL.

Arkansas:		Iowa:	
Marked Tree, St. Francis River	7,504	Bellevue, Mississippi River	1,500

PIKE PERCH.

Disposition.	Eggs.	Fry.
Connecticut:		
Hazardville, Scantic River		200,000
Watertown, Holcomb Pond		500,000
Illinois:		
Grayslake, Chittendens Lake		400,000
Druse Lake		400,000
La Grange, Illinois River		50,000
Meredosia, Meredosia Bay		150,000
Rockefeller, Lake Eara		390,000
Massachusetts:		
Palmer, State fish commission	4,000,000	
Westfield, Hampden Ponds		300,000
Southwick Ponds		300,000
Michigan:		
Ada, Thornapple River		500,000
Alden, Torch Lake		750,000
Algonac, St. Clair River		5,000,000
Alpena, Lake Huron		4,000,000
Bay City, Saginaw Bay		5,500,000
Bellaire, Grass Lake		750,000
Belle Isle Park, Detroit River		1,500,000
Beulah, Crystal Lake		750,000
Detroit, State fish commission	41,700,000	
Elk Rapids, Elk Lake		500,000
Farwell, Otter Lake		500,000
Grass Lake, Tims Lake		500,000
Hillman, Lake Fifteen		500,000
Holly, Hankinson Lake		250,000
School Lot Lake		250,000
Interlochen, Grass and Duck Lakes		500,000
Lake George, Bingo Lake		250,000
Lake George		250,000
Provemont, Lake Leelanau		750,000
Turtle, Honeymoon Lake		200,000
Long Lake		200,000
Wetmore, Long Lake		300,000
Minnesota:		
Carlton, Chub Lake		150,000
Hay Lake		150,000

[a] Lost in transit, 2,905 fingerlings.

DISTRIBUTION OF FISH AND FISH EGGS, BY LOCALITY AND SPECIES, FISCAL YEAR 1913—Continued.

PIKE PERCH—Continued.

Disposition.	Eggs.	Fry.
Minnesota—Continued.		
Cromwell, Island Lake		200,000
Duluth, Schultz Lake		200,000
Erskine, Lake Sarah		200,000
Knife River, Lax Lake		225,000
Nine Mile Lake		225,000
Mankota, Lake Washington		425,000
Pengilly, Swan Lake		375,000
New Hampshire:		
Concord, Penacook Lake		400,000
New York:		
Battery Park, New York Aquarium	500,000	
Binghamton, Susquehanna River		500,000
Canastota, Oneida Lake		300,000
Cape Vincent, St. Lawrence River		2,000,000
Carleton Island, St. Lawrence River		3,000,000
Highland Falls, Roe Lake		300,000
Hudson, Copake Lake		400,000
Lake Charlotte		400,000
Mud Creek, Lake Ontario		4,000,000
Pine Bush, Shawangunk Kill River		400,000
Roscoe, Tennanah Lake		400,000
Wayland, Loon Lake		400,000
West Winfield, Cedar Lake		400,000
North Dakota:		
Burnstad, Red Lake		150,000
Cayuga, Lake Tewaukon		150,000
Jamestown, Spiritwood Lake		300,000
Lisbon, Sheyenne River		400,000
Mott, Cannon Ball River		500,000
Turtle Lake, Turtle Lake		240,000
Ohio:		
Isle St. George, Lake Erie		5,000,000
Kellys Island, Lake Erie		10,000,000
Middle Bass Island, Lake Erie		10,000,000
Monroe, Lake Erie		10,000,000
Oak Harbor, Portage River		1,500,000
Put-in-Bay, Lake Erie		10,000,000
Pennsylvania:		
Chester, Shoens Pond		180,000
Doylestown, Neshaminy Creek		240,000
Echo Lake, Echo Lake		400,000
Kreamer, Middle Creek		400,000
New Milford, Middle Lake		500,000
Susquehanna, Page's pond		300,000
Susquehanna River		500,000
Vermont:		
Alburg, Lake Champlain		2,000,000
Point Farm Creek		1,000,000
Brandon, Fern Lake		400,000
High Pond		500,000
Lake Hortonia		500,000
Burlington, Potash Brook		100,000
Shelburne Bay		200,000
Winooski River		1,700,000
Concord, Hall's pond		500,000
East Highgate, Lake Carmi		500,000
Enosburg Falls, Lake Carmi		500,000
Greensboro, Long Pond		500,000
Highgate, Missisquoi River		3,000,000
Hyde Park, Lake Eden		300,000
Lunenburg, Neal's lake		400,000
Middlebury, Lake Dunmore		1,500,000
Morrisville, Lake Lamoille		400,000
North Ferrisburg, Little Otter Creek		500,000
Rocky Point, Groton Pond		500,000
Rutland, Lake Bomoseen		1,000,000
Shelburn, La Platte River		200,000
Swanton, Lake Champlain		7,130,000
Missisquoi River		19,700,000
Vergennes, Little Otter Creek		500,000
Otter Creek		1,000,000
Wells River, Wells River		500,000
Virginia:		
Adams Grove, Parsons Mill pond		120,000
Danville, Dan River		120,000
Drewryville, Ellis Lake		120,000
South Boston, Dan River		120,000

DISTRIBUTION OF FISH AND FISH EGGS, BY LOCALITY AND SPECIES, FISCAL YEAR 1913—Continued.

PIKE PERCH—Continued.

Disposition.	Eggs.	Fry.
West Virginia:		
Shelton, Elk River		500,000
Wisconsin:		
Amery, Round Lake		200,000
Sucker Lake		200,000
Boyd, Cold Water Creek		100,000
Otter Creek		100,000
Pike Lake		100,000
Upper Hay Creek		100,000
Cable, Perry Lake		150,000
Swensen Lake		150,000
Colfax, Lake Colfax		250,000
Crandon, Acmabet Lake		200,000
Lake Metonga		200,000
Rich's lake		200,000
Rollingstone Lake		200,000
Squaw Lake		200,000
Cumberland, Lake Vermilion		175,000
Long Lake		250,000
Turtle Lake		250,000
Donaldson, Landing Lake		200,000
Pickerel Lake		200,000
Elcho, Otter Lake		200,000
Fifield, Long Lake		150,000
Gordon, Bond Lake		150,000
Clear Lake		150,000
Eau Claire Lake		150,000
Whitefish Lake		150,000
Gillett, Savage Lake		300,000
Hayward, Hansen Lake		150,000
Medford, Hull's lake		150,000
Mellen, Lake Gallilee		225,000
Nashville, Battawegamog Lake		200,000
Crane Lake		200,000
Rice Lake		200,000
Newald, Lily Lake		400,000
Pelican, Pelican Lake		300,000
Phelps, Bass Lake		200,000
Phillips, Bass Lake		150,000
Lake Duroys		150,000
Long Lake		150,000
Solon Springs, Twin Lake		150,000
Stanley, Jump River		200,000
Outles Lake		150,000
Pike Lake		150,000
Stone Lake, Whitefish Lake		150,000
Sand Lake		150,000
Superior, Aminicon Lake		400,000
Three Lakes, Eagle River		600,000
Long Lake		300,000
Moccasin Lake		200,000
Spirit Lake		200,000
Wabeno, Nimley Lake		100,000
Richardson's lake		200,000
Shoe Lake		100,000
Zarline Lake		100,000
Total [a]	46,200,000	148,510,000

[a] Lost in transit, 70,000 fry.

YELLOW PERCH.

Disposition.	Eggs.	Fry.	Fingerlings.
Connecticut:			
Deep River, State fish commission	5,000,000		
Newton, Taunton Lake			200
Waterbury, Long Meadow Pond			200
Delaware:			
Felton, Lakeside Pond		400,000	
Mordington Mill pond		400,000	
District of Columbia:			
Washington, Potomac River		2,140,000	

DISTRIBUTION OF FISH AND FISH EGGS, BY LOCALITY AND SPECIES, FISCAL YEAR 1913—Continued.

YELLOW PERCH—Continued.

Disposition.	Eggs.	Fry.	Fingerlings.
Georgia:			
Cairo, Cross Roads Pond			22
Empire, Carnes Pond			60
Jackson, Ocmulgee Lake			60
Tifton, Ferry Lake			150
Goodman Lake			150
Gunn Lake			75
Williams's lake			75
Illinois:			
Decatur, Decatur Club Lake			580
Everett, Armour's lake			375
Grayslake, Druse Lake			240
Greenville, De Moulin's lake			250
Watseka, Iroquois River			250
Wilmington, Forked Creek			375
Indiana:			
Albion, Conrad Lake			200
Indianapolis, White River			500
Jeffersonville, Government Pond			200
Marion, Andrew's pond			200
Iowa:			
Amana, Amana Lake			900
Bedford, Cobb's pond			150
Centerville, Sanders's pond			150
Chariton, Crystal Lake			300
Creston, Summit Lake			450
Lenox, Beach's pond			300
Leon, Caster Lake			150
Lime Springs, Upper Iowa River			1,500
Kansas:			
Kingman, Anawalt's pond			142
Crappie Club Lake			143
Hamilton Pond			143
Lakeside Pond			143
Riverside Pond			143
Russell Pond			143
Spring Lake			143
Kentucky:			
Erlanger, Stock Farm Pond			100
Julien, Stamper's pond			100
Willow Pond			100
Louisville, Lake Lansdowne			300
Morehead, Triplett Creek			250
Mount Sterling, Rayborn's pond			100
Waterworks Lake			150
New Hope, Belle of Nelson Pond			100
Owensboro, Raid's lake			600
Somerset, Pitman Creek			300
Williamsburg, Cumberland River			400
Maryland:			
Accokeek Creek, Potomac River		39,225,000	
Annapolis, Severn River		1,000,000	
Broad Creek, Potomac River		15,514,000	
Bush River Station, Bush River		5,000,000	
County Bridge, Bohemia River		5,000,000	
Elkton, Elk River		30,000,000	
Frederick, Bush Creek		3,800,000	
Furnace, Furnace Creek		20,000,000	
Georgetown, Sassafras River		4,000,000	
Great Falls, Potomac River			200
Gunpowder, Gunpowder River		5,000,000	
Hagerstown, Antietam Creek		500,000	
Conococheague Creek		500,000	
Potomac River		1,000,000	
Harford, Swan Creek		37,060,000	
Havre de Grace, Chesapeake Bay		40,000,000	
Highfield, Lake Royer		400,000	
Lapidum, Susquehanna River		25,000,000	
McDaniel, Lovers Cove		300,000	
Middle River, Middle River		1,000,000	
North East, North East River		18,900,000	
Piscataway Creek, Potomac River		9,500,500	
Pohick Creek, Potomac River		6,000,000	
Queenstown, Queenstown Creek		300,000	
Robinson Point Elk River		6,000,000	
Showell, St. Martins River, Showell Fork		300,000	
Smithsburg, Raven Rock Reservoir		500,000	
Swan Creek, Potomac River		6,533,500	

DISTRIBUTION OF FISH AND FISH EGGS, BY LOCALITY AND SPECIES, FISCAL YEAR 1913—Continued.

YELLOW PERCH—Continued.

Disposition.	Eggs.	Fry.	Fingerlings.
Maryland—Continued.			
Townpoint, Bohemia River		15,000,000	
Williamsport, Conococheague Creek		500,000	
Potomac River		1,000,000	
Massachusetts:			
Lee, Greenwater Pond		300,000	
Upper Goose Pond		300,000	
Palmer, State fish commission	5,000,000		
Ware, Hardwick Lake		400,000	
Michigan:			
Brighton, Beech's lake			375
Detroit, State fish commission		3,500,000	
Holly, Long Lake			200
Newaygo, Great Marl Lake			250
Kimbell Lake			250
Pickerel Lake			250
Rose Center, Bennett Lake			250
Buckhorn Lake			375
North Buckhorn Lake			375
Mississippi:			
Corinth, Farm Lake			100
Erwin, Lake Washington			400
Hernando, Dockery Pond			150
Moon, Moon Lake			300
West Point, Harmon Lake			300
Sand Creek Lake			200
New Hampshire:			
Newport, Rockybound Pond			200
New Jersey:			
Morris Plains, Jacqui's pond		300,000	
Newark, State fish commission		2,000,000	
Waldwick, Hohokus River		400,000	
New York:			
Battery Park, New York Aquarium	1,000,000		
Camden, Fish Creek			100
Cornwall, Sutherland's pond			250
Edmeston, Summit Lake			120
Garrison, Reeve's pond		200,000	125
Mastic, Home Creek			125
North Carolina:			
Lexington, Nokomis Cotton Mill pond			200
Maxton, Lumber River			200
Oxford, Cannady's lake			300
Rockingham, Ranch Pond			200
Salisbury, Josey's pond			200
South River			400
Towflings Ice Pond			200
Stovall, Gregory Pond			200
Taylorsville, Adams's pond			200
Williamston, Foster Mill pond			300
Ohio:			
Chippewa Lake, Chippewa Lake			300
Leetonia, Cherry Valley Pond			250
Put-in-Bay, Lake Erie		3,000,000	
Youngstown, Lake Hamilton			250
Oklahoma:			
Ardmore, City Lake			150
Bliss, Salt Valley Creek			400
McAlester, Cole's lake			300
Okmulgee, Lake Park Lake			1,000
Oregon:			
Carlton, Carlton Lake			250
Pennsylvania:			
Cambridge Springs, Edinboro Lake			375
Choconut, Quaker Lake		400,000	
Ebensburg, Lake Rowena		300,000	
Frazer, Ridley Creek		400,000	
Hosensack, Hancock's pond			200
Walters Pond			200
Lenape, Brandywine Creek		500,000	
Lititz, Hammer Creek Pond		300,000	
Munster, Clearfield Pond		200,000	
Naomi Pines, Naomi Lake		500,000	
Washington Borough, Susquehanna River		1,000,000	
Williamsburg, Flowing Spring Ponds		200,000	
Rhode Island:			
Kenyon, Ninigret Pond			100

DISTRIBUTION OF FISH AND FISH EGGS, BY LOCALITY AND SPECIES, FISCAL YEAR 1913—Continued.

YELLOW PERCH—Continued.

Disposition.	Eggs.	Fry.	Fingerlings.
South Dakota:			
Kadoka, Lake Lorelei			200
Weta, Weta Lake			200
Tennessee:			
Knoxville, Fresh Water Lake			300
Vermont:			
Alburg, Point Farm Creek		200,000	
East Fairfield, Black Creek		500,000	
Kings Hill Pond		100,000	
Metcalf Pond		900,000	
Enosburg Falls, Inland Pond		500,000	
Lyndonville, Center Pond		400,000	
Chandler Pond		400,000	
Lilly Pond			100
Pasture Pond		400,000	
Milton, Round Pond		400,000	
Plainfield, Lake Nelson		400,000	
Rutland, Otter Creek		500,000	
Swanton, Missisquoi River		5,000,000	
West Danville, Joe's pond		1,400,000	
Virginia:			
Ashburn, Goose Creek		500,000	
Dogue Creek, Potomac River		9,000,000	
Emporia, Goodwyn's pond		300,000	
Little Hunting Creek, Potomac River		13,371,500	
Pohick Creek, Potomac River		14,778,500	
Richmond, Licking Creek Pond		300,000	
Rock Castle, Finch's pond		400,000	
Washington:			
Tacoma, American Lake			125
Gravelly Lake			125
Steilacoom Lake			250
West Virginia:			
Charleston, White City Lake			250
Wisconsin:			
Elkhart Lake, Elkhart Lake			300
La Crosse, Bank Creek			100
Broken Gun Creek			75
Flat Pond			75
Second Bank Creek			100
Sheboygan Falls, Sheboygan River			300
Total [a]	11,000,000	365,723,000	25,132

STRIPED BASS.

North Carolina:			
Weldon, Roanoke River		7,234,000	

WHITE PERCH.

Connecticut:			
Forestville, Grannis's pond		200,000	
Ridgefield, Great Pond		300,000	
Rockville, Poehnert's pond		200,000	
Simsbury, Wood's pond		300,000	
Maine:			
Bar Mills, Eagles Pond		400,000	
North Berwick, Ell Pond		300,000	
Maryland:			
Annapolis, Sodens Pond		200,000	
Bohemia River, Bohemia River		15,000,000	
Bush River, Bush River		10,000,000	
Chase, Dundee Creek		500,000	
Elk River, Elk River		25,800,000	
Furnace, Furnace Creek		10,000,000	
Gunpowder, Gunpowder River		10,000,000	
Havre de Grace, Chesapeake Bay		279,650,000	
Susquehanna River		58,000,000	
McDaniels, Lovers Cove		300,000	
Pond Cove		300,000	

[a] Lost in transit, 1,525 fingerlings.

DISTRIBUTION OF FISH AND FISH EGGS, BY LOCALITY AND SPECIES, FISCAL YEAR 1913—Continued.

WHITE PERCH—Continued.

Disposition.	Eggs.	Fry.	Fingerlings.
Maryland—Continued.			
Queenstown, Blunts Creek		200,000	
Robinson Station, Magothy River		500,000	
Spesutie Narrows, Chesapeake Bay		10,000,000	
Swan Creek, Chesapeake Bay		10,000,000	
Townpoint, Elk River		5,000,000	
Massachusetts:			
Congamond, Congamond Lake		500,000	
Fitchburg, Ward Pond		300,000	
Hudson, Lake Boon		400,000	
Palmer, State fish commission	15,000,000		
New Hampshire:			
Greenfield, Gould Pond		300,000	
Otter Lake		300,000	
Lakewood, Ossipee Lake		500,000	
Newport, Long Pond		300,000	
Newton Junction, Country Pond		400,000	
New Jersey:			
Newark, State fish commission		2,000,000	
New York:			
Great Neck, applicant	5,000,000		
Middletown, Ketchums's pond		400,000	
Wallkill, Shawangunk Kill River		500,000	
Wayland, Loon Lake		800,000	
North Carolina:			
Edenton, Edenton Bay		3,270,000	
Pennsylvania:			
Washington Borough, Susquehanna River		1,000,000	
Vermont:			
Barton, Parker Pond		300,000	
Hardwick, Greenwood Lake		400,000	
North Bennington, Lake Paran		300,000	
Virginia:			
Montpelier, Du Pont's pond			121
West Virginia:			
Shepherdstown, Potomac River			600
Total	20,000,000	449,120,000	721

YELLOW BASS.

Illinois:			
Jacksonville, Nichols Park Lake			255

SMELT.

Maine:			
Green Lake, Green Lake		500,000	
Otis, Green Lake		1,350,000	
Maryland:			
Great Falls, Potomac River			27,000
New York:			
Delhi, applicant	4,500,000		
Total	4,500,000	1,850,000	27,000

COD.

Disposition.	Eggs.	Fry.
Maine:		
Boothbay Harbor, Boothbay Harbor		1,206,000
Hodgdons Cove		1,863,000
Linekin Bay		676,000
Townsend Gut		757,000
Southport, Deckers Cove		649,000
Ebencook Harbor		460,000

DISTRIBUTION OF FISH AND FISH EGGS, BY LOCALITY AND SPECIES, FISCAL YEAR 1913—Continued.

COD—Continued.

Disposition.	Eggs.	Fry.
Massachusetts:		
Beverly, Massachusetts Bay		32,260,000
Falmouth, Eel Pond		2,400,000
Nantucket Sound		16,580,000
Vineyard Sound		2,925,000
Gloucester, Atlantic Ocean	6,800,000	22,700,000
Ipswich Bay		4,910,000
Gosnold, Buzzards Bay		7,678,000
Vineyard Sound		72,107,000
Manchester, Massachusetts Bay		7,880,000
Marblehead, Massachusetts Bay		10,500,000
Rockport, Atlantic Ocean		6,010,000
Ipswich Bay		20,890,000
Tisbury, Nantucket Sound		7,329,000
West Tisbury, Vineyard Sound		1,232,000
Total	6,800,000	221,012,000

POLLOCK.

Massachusetts:		
Annisquam, Ipswich Bay		6,350,000
Beverly, Massachusetts Bay		69,370,000
Eastern Point, Atlantic Ocean		540,000
Gloucester, Annisquam River		1,640,000
Atlantic Ocean	133,739,000	46,370,000
Ipswich Bay		37,420,000
Ipswich, Ipswich Bay		7,000,000
Lanesville, Ipswich Bay		57,370,000
Manchester, Massachusetts Bay		44,000,000
Marblehead, Massachusetts Bay		35,000,000
Rockport, Atlantic Ocean		31,610,000
Ipswich Bay		74,390,000
Salem, Massachusetts Bay		19,000,000
Total	133,739,000	430,060,000

HADDOCK.

Maine:		
Boothbay Harbor, Boothbay Harbor		22,967,000
Massachusetts:		
Beverly, Massachusetts Bay		6,110,000
Gloucester, Atlantic Ocean	57,868,000	15,000,000
Marblehead, Massachusetts Bay		5,540,000
Rockport, Atlantic Ocean		11,270,000
Ipswich Bay		7,370,000
Total	57,868,000	68,257,000

FLATFISH.

Disposition.	Fry.	Disposition.	Fry.
Maine:		Massachusetts—Continued.	
Boothbay, Linekin Bay	64,473,000	Falmouth, Eel Pond	100,000
Sheepscot River	3,024,000	Great Harbor	10,421,000
Boothbay Harbor, Boothbay Harbor	49,666,000	Nantucket Sound	92,080,000
Hodgdons Cove	6,040,000	Waquoit Bay	5,359,000
Linekin Bay	76,483,000	Gloucester, Annisquam River	41,370,000
Mill Cove	71,887,000	Gloucester Harbor	97,710,000
Townsend Gut	21,425,000	Gosnold, Hadley Harbor	4,338,000
East Boothbay, Linekin Bay	28,814,000	Vineyard Sound	41,293,000
Southport, Deckers Cove	9,166,000	Lanesville, Ipswich Bay	8,000,000
Ebencook Harbor	49,333,000	Manchester, Massachusetts Bay	29,290,000
Sheepscot River	18,270,000	Rockport, Rockport Harbor	18,600,000
West Boothbay Harbor, West Boothbay Harbor	15,380,000	Wickford, Wickford Harbor	11,648,000
Massachusetts:		Total	809,270,000
Beverly, Massachusetts Bay	22,000,000		
Essex, Essex River	13,100,000		

DISTRIBUTION OF FISH AND FISH EGGS, BY LOCALITY AND SPECIES, FISCAL YEAR 1913—Continued.

LOBSTER.

Disposition.	Fry.	Disposition.	Fry.
Maine:		Maine—Continued.	
Barnard, Bass Harbor	2,700,000	St. George, Matinicus Harbor	3,000,000
Biddeford, Wood Island Harbor	1,000,000	Seal Harbor	6,000,000
Biddeford Pool, Biddeford Pool Harbor	3,000,000	South Addison, Little Kennebec River	500,000
Boothbay, Back River	2,000,000	Wass Cove	500,000
Boothbay Harbor	5,500,000	South Hancock, Skillings River	2,000,000
Squirrel Island Harbor	500,000	Sorrento, Sorrento Harbor	2,000,000
Bristol, Christmas Cove	1,500,000	Southport, Ebencook Harbor	3,500,000
Johns Bay	2,000,000	Pig Cove	5,000,000
Cape Porpoise, Cape Porpoise Harbor	3,000,000	Spruce Head, Penobscot Bay	8,750,000
Corea, Indian Harbor	4,000,000	Stonington, Stonington Harbor	3,600,000
Crockett River, Crockett River	375,000	Swans Island, Swans Island Harbor	3,600,000
Cushing, Medencook River	6,000,000	Tremont, Duck Cove	400,000
Deer Isle, Grays Cove	1,300,000	Vinal Haven, Penobscot Bay	1,750,000
East Boothbay, Linekin Bay	3,500,000	Sandy Cove	3,000,000
Eastport, Broad Cove	5,000,000	Wells, Wells Bay	2,000,000
East Stuban, Dyers Bay	5,000,000	West Bath, New Meadows Cove	1,000,000
Friendship, Friendship Harbor	5,500,000	Westport, Goose Rock Passage	1,000,000
Georgetown, Fire Isle Harbor	3,000,000	Hocomock Bay	1,000,000
Harmons Harbor	5,000,000	White Island, Penobscot Bay	125,000
Gouldsboro, Corea Harbor	200,000	Winter Harbor, Winter Harbor	2,000,000
Prospect Harbor	300,000	Wiscasset, Sheepscot River	500,000
Harpswell, Harpswell Sound	1,500,000	York, York Harbor	2,000,000
Quohog Bay	8,000,000	Massachusetts:	
Isle of Shoals, Isle of Shoals Harbor	1,500,000	Beverly, Massachusetts Bay	2,200,000
Jonesport, Monsapec Reach	1,000,000	Boston, Boston Harbor	500,000
Kennebunk Port, Kennebunk Port Harbor	4,000,000	Hull, Hull Harbor	500,000
Kittery, Pepperell Cove	4,000,000	Gloucester, Annisquam River	1,200,000
Matinicus, Matinicus Harbor	1,000,000	Atlantic Ocean	1,930,000
Millbridge, Dyers Bay	1,000,000	Ipswich Bay	600,000
Monhegan, Monhegan Harbor	1,500,000	Massachusetts Bay	300,000
Mount Desert, Seal Harbor	200,000	Lanesville, Ipswich Bay	500,000
Southwest Harbor	4,400,000	Manchester, Massachusetts Bay	1,300,000
New Harbor, New Harbor	2,500,000	Marblehead, Massachusetts Bay	1,000,000
North Cutler, Northwest Harbor	2,500,000	Rockport, Atlantic Ocean	2,450,000
Starboard Isle Harbor	2,500,000	Ipswich Bay	400,000
North Haven, North Haven Harbor	1,800,000	Rockport Harbor	600,000
Ogunquit, Wells Bay	2,000,000	Salem, Massachusetts Bay	400,000
Pemaquid Harbor, Pemaquid Harbor	5,000,000	New Hampshire:	
Port Clyde, Port Clyde Harbor	1,500,000	Hampton, Atlantic Ocean	300,000
Portland, Peak Island Roads	2,500,000	Hampton Harbor	2,500,000
Portland Harbor	2,500,000	Rye Harbor	1,000,000
Prospect Harbor, Prospect Harbor	4,000,000	Isle of Shoals, Gosport Harbor	300,000
Rockland, Rockland Harbor	5,000,000	New Castle, Little Harbor	4,000,000
Rockport, Rockport Harbor	3,000,000	New Jersey:	
Sagadahoc, Sagadahoc Bay	1,000,000	Cape May, Atlantic Ocean	[a]200
		Cape May Harbor	200,000
		Total [b]	199,680,200

[a] Adult lobsters.

[b] Lost in transit, 800,000 fry.

ALASKA FISHERIES AND FUR INDUSTRIES IN 1913

BARTON WARREN EVERMANN
Chief of Alaska Fisheries Service

Appendix II to the Report of the U. S. Commissioner
of Fisheries for 1913

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ALASKA FISHERIES AND FUR INDUSTRIES IN 1913.

GENERAL ADMINISTRATIVE REPORT.

By Barton Warren Evermann,
Chief, Alaska Fisheries Service.

As in the annual reports of the Alaska Fisheries Service for 1911 and 1912, the reports on the fur-seal service, the Alaska salmon and other fisheries, and the minor fur industries are combined in one general report.

The returns from these industries in 1913 may be stated as follows:

Fisheries	$15,739,068
Pribilof furs (seal and fox)	83,667
Minor furs	678,062
Total	16,500,797

For the fisheries the figures are less than for last year, when the value was $18,877,480; and as 1913 was the first year of the five-year close season on the Pribilofs, the catch of seals was arbitrarily reduced to such number as the natives required for food. The value of the seal catch was thus only $66,095, as compared with $141,290.32 in 1912, and this with an also lessened take of foxes, valued at $17,572, against $22,209.91 in 1912, totals only $83,667 from the Pribilof Islands, a decrease of $79,883.23 as compared with the 1912 total for these islands. The minor furs, from the mainland chiefly, showed an important increase, from $630,656 in 1912 to $678,062 in 1913.

SALMON FISHERIES.

INSPECTION.

The inspection of the salmon and other fisheries of Alaska was carried on during the season of 1913 in accordance with the general plan of previous years. The field force was assigned as follows: In western Alaska, Assistant Agent H. C. Fassett canvassed the fisheries of the Kvichak Bay region and westward to Port Moller, and Deputy Fur Wardens G. Dallas Hanna and Claude J. Roach carried on the investigations at Nushagak Bay and Wood River. In central Alaska Inspector E. M. Ball was on duty for the Afognak-Kodiak region. In southeast Alaska Assistant Agent Ward T. Bower conducted the

inspection and canvass for fishery statistics, assisted by Deputy Wardens E. P. Walker and Fred H. Gray; also by James H. Lyman, of the Yes Bay station force. Agent H. O. Smith reached southeast Alaska in time to take part in the closing portion of the season's work.

Detailed reports on the salmon inspection are published on page 37 and following.

NEW STEAMER FOR PATROL WORK.

In the fall of 1912 the Bureau purchased the steamer *Wigwam* from the Alaska Packers Association, and the vessel was given the new name *Osprey*. The vessel was built in 1895 at San Francisco, and is of 40 tons gross measurement, 72 feet in length, 17 feet beam, and 6 feet in depth. It is of staunch construction, and within the last few years has been rebuilt in many essentials. Before purchase it was put in first-class shape in accordance with recommendations of the Steamboat-Inspection Service.

The vessel is equipped with a Scotch boiler, and a compound engine, and has a dynamo directly connected to a high-speed Corliss engine. A steam winch is on the main deck forward, while below is a forecastle with quarters for six men; also three more of the crew may be quartered on the boat deck in the pilot-house structure. The galley and dining room are on the main deck forward immediately below the pilot house. The after cabin is arranged to accommodate four persons. It is finished in Spanish cedar and is provided with folding berths. The vessel has two masts.

The appropriation for a crew was not effective until July 1, 1913, and it was necessary to defer putting the vessel in commission until then. During the winter it was upon the ways at Semiahmoo, Wash. A crew was provided consisting of master, engineer, two firemen, seaman, and cook, and on July 8 the *Osprey* sailed from Semiahmoo for Alaska to enter upon patrol and other work in the southeast district. The vessel has been in commission continuously since that time. During the active salmon-fishing season operations were confined more particularly to the more open and exposed waters in the upper part of southeast Alaska, with headquarters at Juneau. The Ketchikan and Wrangell districts were covered by smaller chartered boats. Winter headquarters have been selected at Wrangell, which is a central point and has good harbor facilities.

From July until the end of the year the *Osprey* logged approximately 7,000 knots. Under normal conditions a speed of more than 8 nautical miles per hour is maintained easily. On the average a ton of coal is good for 50 miles' steaming. With bunker space for only 7½ tons this gives a steaming radius of but 350 miles. This is entirely inadequate for the service demanded of the *Osprey*, and, as a makeshift, the expedient was resorted to of carrying sack coal in the after hold, a most unsatisfactory proceeding.

At the earliest opportunity the vessel should be converted to an oil burner. The steaming radius can thus be more than doubled, and the cost of operation will be reduced. Another point is that the identity of the boat will be less obvious. Since so few cannery tenders in southeast Alaska are now operated by steam, the appearance of smoke affords most conspicuous notice of approach and may give sufficient warning to enable any violators of the law to remove all evidence of their illegal fishing.

Aside from the positions of master and engineer, much trouble has been experienced in keeping a crew on the *Osprey*. This is because of the fact that in fixing the rates of pay Congress did not make provision for subsistence allowances. After each man pays his share of the mess bill the net wage balance is so small as to offer no inducement for service. Either a 20 per cent increase in pay should be made by Congress covering these positions, or the equivalent in subsistence allowances should be granted. It is the universal custom on all commercial craft in Alaska waters to furnish employees with subsistence, and in order to secure good men the Government must at least meet the rates generally prevailing for similar service. The scheme followed in the Lighthouse Service or in the Coast and Geodetic Survey could well be adopted.

Another necessity is the addition of one or two seamen to the regular crew. This is essential to keep the vessel in good condition, particularly during the several months' active patrol duty when running is constant and heavy.

COOPERATION WITH THE TERRITORIAL LEGISLATURE.

As provided in the enabling act creating a legislative assembly for the Territory of Alaska, the legislature convened at Juneau, March 3, 1913. In response to a request made by the governor of Alaska the Department of Commerce sent Assistant Salmon Agent Ward T. Bower to be present at Juneau during the session for the purpose of furnishing to committees and members information regarding fishery matters when requested by them to do so. The questions considered by the legislature are discussed on pages 37 to 46 of this report.

FUR-SEAL SERVICE.

During the entire fiscal year 1912–13, Agent Lembkey and Assistant Agent Proctor were resident on the seal islands, the former in charge on St. Paul, the latter on St. George. Assistant Agents Judge and Clark who had been continuously on the islands since June, 1911 (excepting in the case of Mr. Judge, who in the middle of the summer of 1912 made a trip on the *Homer* to San Francisco for the purpose of purchasing supplies), returned in October to Washington, where they were assigned to duty until in May, 1913, when they were ordered to San Francisco to purchase supplies for the islands.

The steamer *Homer* was again chartered for the purpose of carrying supplies to the islands and bringing down the skins in the fall. The vessel sailed from San Francisco with the supplies on board June 23. Fred M. Chamberlain, who had been appointed naturalist, fur-seal service, vice M. C. Marsh, resigned, and George A. Clark, who had been appointed special investigator to take the census of the seal herd, took passage on the steamer to the islands. The steamer arrived at St. Paul Island July 13. After landing the supplies, including coal from Unalaska, for which a special trip had to be made, the seal and fox skins were taken on board August 8, and the *Homer* sailed for San Francisco, where she arrived August 24, Messrs. Lembkey and Clark returning on the vessel.

SALE OF FUR-SEAL SKINS AND FOX SKINS.

In former years the fur-seal skins taken on the Pribilof Islands were shipped to London for sale, that being the principal market of the world for such skins. In some years London received as many as 100,000 from the Pribilofs alone. It was thought that if the Government could secure even approximately the same price for skins sold in the United States that could be obtained in London a change of market was demanded by business and patriotic considerations. The take of sealskins in 1913, owing to the establishment of a close season on seals, numbered but 2,296, and the occasion was deemed auspicious for making an attempt to build up an American industry dependent upon the selling and dyeing of fur-seal skins.

After due consideration the Department decided to send the sealskins to the St. Louis market for sale at auction by Messrs. Funsten Bros. & Co. The previous administration had considered the advisability of selling the skins in America, and this year Funsten Bros. & Co. was the only firm actively soliciting the business at the time when it was necessary for arrangements to be made. More favorable commission rates were secured from the St. Louis firm than had previously been secured at the London market in respect to both fur-seal skins and fox skins and, in addition, transportation rates from the Pribilof Islands to St. Louis were much less than to London.

The year's shipment of sealskins was, therefore, consigned to Messrs. Funsten Bros. & Co., at St. Louis, Mo., where, with the exception of 400 skins which were withdrawn from immediate sale by the Department at the request of the chairman of the Committee on Expenditures in the Department of Commerce, House of Representatives, they were sold on December 16, 1913. The gross proceeds of the sale amounted to $54,579, or an average price of $28.78 per skin.

Excluding 20 defective blue fox skins which were shipped directly to Washington for examination, the 1913 shipment of fox skins from

the Pribilof Islands consisted of 405 blue fox skins and 31 white fox skins. These skins were included with the consignment of fur-seal skins to Messrs. Funsten Bros. & Co. and were sold by that firm on the same date as the sealskins. The 405 blue fox skins sold for $17,094, or an average of $42.20 per skin, and the 31 white fox skins for $458, or a total of $17,552. It is worthy of mention that one lot of six blue fox skins sold for $948, or at an average price of $158.

The net proceeds to the United States Government on account of the sale of sealskins and the fox skins here noted, after deducting freight, commission, and miscellaneous expenses, were $67,660.51.

There yet remain for sale at the close of 1913 the 400 sealskins withdrawn from the December, 1913, sale, as noted above. The estimated value of these is $11,516. The 20 defective blue fox skins which were shipped to Washington were found to be nearly worthless and were disposed of by informal sale for $20 for the lot.

FUR-SEAL SKINS TAKEN BY COAST INDIANS.

Usually in the months of April and May the Alaska fur-seal herd migrates northward along the coast of the Pacific States, British Columbia, and southeast Alaska, en route to the breeding grounds on the Pribilof Islands. By the terms of the convention of July 7, 1911, certain Indians dwelling on the Pacific coast are permitted to kill fur seals under prescribed regulations. The only Indians to avail themselves of this privilege were residents of the La Push Reservation near the mouth of Quiniault River in the southwestern part of Clallam County, Wash.

The first seal was killed April 14 and the last on May 25, the total being 91, of which 90 were reported as females. The best day was April 15, when 42 were taken. All killing was by means of spears. The table which follows shows dates of killing.

DATES OF KILLING AND SEX OF FUR SEALS TAKEN BY INDIANS OFF COAST OF WASHINGTON, SEASON OF 1913.

Date.	Females.	Males.	Total.	Date.	Females.	Males.	Total.
1913.				1913.			
Apr. 14	2		2	Apr. 25	3		3
15	42		42	26	3		3
17	1		1	28	2		2
18	7	1	8	30	1		1
20	12		12	May 1	4		4
21	6		6	25	1		1
22	4		4				
23	2		2	Total	90	1	91

There were 13 Indians engaged in killing. One got 17 seals, while the two next successful hunters got 13 each. The others varied from 11 down to 1 each. The largest skin as to dimensions was 55½ inches long by 31 inches wide. The heaviest skin was reported as weighing

13 pounds and 14 ounces. The smallest skin was 30½ inches long, 18 inches wide, and weighed 3 pounds. The averages for the 91 skins are: Length, 43 inches; width, 24 inches; weight, 6 pounds 14 ounces. All skins were measured, weighed, and authenticated June 4 and 5, at Mora, Wash., by Donald S. McLeod, local agent of the bureau with station at Seattle, Wash. A leather tag was attached to each skin, and a certificate issued to accompany same.

Since the international convention of July 7, 1911, which among other things prohibits the natives from killing fur seals by means of firearms, no seals have been taken by the natives in the vicinity of Sitka. The last hunt was in the spring of 1911, as the seals were migrating northward, and the number killed was 139. In 1910 it was 135, and in 1909, 397. After the prohibition against firearms became effective, it seemed the natives were too proud to resort to the primitive spears of a generation before, and moreover, there were only a few of the older natives left who were experienced in the use of spears. The recent extension of fishing operations has afforded ample employment for all natives who formerly spent part of each spring in sealing.

MINOR FUR INDUSTRIES.

FIELD WORK.

The field force employed to enforce the regulations in regard to the capture of fur-bearing animals in Alaska other than fur seals consisted of Warden Harry J. Christoffers and a corps of deputies, namely, G. Dallas Hanna, who was transferred to the Pribilof Islands during the year and was succeeded by Ernest P. Walker; Claude J. Roach, who resigned August 7 and was succeeded by Calvin F. Townsend; Fred H. Gray, and Logan I. Evans. Mr. Christoffers was on duty at Seward and later at Fairbanks. Messrs. Evans and Townsend were detailed at different times under the immediate direction of Warden Christoffers. Messrs. Hanna and Roach were at various places, including the Nushagak region, where they had local charge of the fisheries inspection work and also attended to the taking of the census of red salmon ascending Wood River. Messrs. Walker and Gray were detailed to southeast Alaska.

Early in 1913 the governor of Alaska found it impracticable to continue for the Territory the services of the warden and four deputy wardens of the Bureau's force, who had been appointed special game wardens to assist in a more effective enforcement of the game laws. The Bureau, however, finds it desirable to continue as special fur wardens the services of the four regular game wardens appointed by the governor under the reciprocal arrangement of last year. They are paid a nominal salary and are invested with full powers to enforce the provisions of the fur laws.

ENFORCEMENT OF REGULATIONS.

Seizures and confiscations.—The revised regulations for the protection of the fur-bearing animals in Alaska, approved by the Secretary of Commerce, under date of March 26, 1913, contain the following provisions:

> No person shall purchase, offer to purchase, sell, offer for sale, or export, or have in possession the unprime skin or pelt of any fur-bearing animal in the Territory of Alaska.
>
> It shall be the duty of the fur warden, deputy fur wardens, special fur wardens, and other officers designated by the Secretary of Commerce to seize and confiscate all unprime skins found in the unlawful possession of any person in Alaska or in process of shipment from Alaska.

In accordance with these provisions the deputy wardens stationed at Nushagak seized in that vicinity during the spring of 1913 approximately 1,200 muskrat skins, 80 mink skins, and 24 fox skins, all of which were unprime and had been taken during the close seasons. These skins were delivered into the custody of the United States marshal at Valdez, Alaska.

After giving due consideration to the matter the Secretary ordered that these skins be confiscated and sold for the account of the United States Government. This action on the part of the Secretary was sustained by an opinion of the solicitor of the Department. The skins have since been shipped to St. Louis, where they will be sold at the Funsten Fur Exchange at public auction for the account of the United States.

In southeast Alaska a number of unprime mink skins found in the possession of various parties were seized and confiscated.

The present regulations prohibit the killing of any beaver prior to November 1, 1918. At Quadra Lake, southeast Alaska, in the fall of 1913, deputy warden Fred H. Gray learned of the trapping of a beaver. An investigation was made which led to the arrest of an Indian, Frank Mark, and to the seizure of a fresh beaver skin. Mark confessed his guilt, and he was taken to Ketchikan, where he pleaded guilty in the United States Commissioner's court. The minimum fine of $200 was imposed. The circumstances showed that Mark was not making a regular practice of trapping beaver.

Unprime skins.—The more responsible furriers are in hearty sympathy with the Department regulation which prohibits the handling of unprime skins in the Territory of Alaska and makes any unprime skin subject to confiscation.

It is hoped that trappers can soon be brought to a realization of the fact that it is directly to their interest to take no unprime furs, for even though the number so taken be smaller, the aggregate price will be even greater than would be realized from a larger number of animals taken when the fur is not prime.

The under side of a prime skin is of a yellowish white color. When the fur begins to grow unprime the flesh side of the skin takes on a bluish coloration, first on the back of the head, and it then extends back and finally envelops the whole skin. In the fall when the skin is beginning to grow prime again the bluish coloration disappears, first from the extremities and finally from the head. The absence of the long guard hair from the fur is an indication of unprimeness. Bluish spots on the flesh side of the skin indicate an unprime state. Skins showing dark patches on the under side, with fur coming through, are not necessarily unprime, as this may be due to a diseased condition of the animal.

Poison.—The killing of fur-bearing animals with poison is contrary to the Department's regulations, and during the last year or so its use has been much lessened. Certain trade publications, however, continue to advertise the sale of poison, thereby ignoring the Government regulations which have been thoughtfully framed with a view to perpetuating the supply of fur-bearing animals, and tempting hunters and trappers to transgress. Attention is invited to the Criminal Code of Alaska (Title I, chap. 13, sec. 186), which states that all persons concerned in the commission of a crime, whether they directly commit the act constituting the crime or aid and abet in its commission, though not present, are principals, and to be tried and punished as such. Thus, since it is illegal to kill fur-bearing animals with poison, any person selling it for this purpose becomes liable as contributing to the commission of a crime.

NEW REGULATIONS.

Bounty on wolves.—Among the memorials addressed to Congress by the Legislature of Alaska at its first session was one asking that a bounty be placed upon wolves. Favorable action in this direction is recommended. Wolves are destructive to deer, and as the latter are of far greater economic value, means should be taken to reduce the number of wolves. A bounty of $10 on each wolf killed in the Territory, together with the market value of the skin, amounting usually from $2 to $5, would insure a return sufficiently remunerative to stimulate an active campaign against wolves. They are particularly bad in southeast Alaska.

Beaver.—The close season on beaver has been extended to November 1, 1918. By that time it is hoped that they will have become sufficiently numerous again to permit of their being trapped.

Black bear.—In response to a general request by residents of Alaska, one feature of the regulations issued by the Secretary of Commerce under date of March 26, 1913, places the black bear, along with the wolf and wolverine, in the list of fur-bearing animals that may be legally killed at any time.

STATISTICS OF MINOR FURS SHIPPED FROM ALASKA.

Under the regulations all shipments of furs from Alaska must be reported to the Bureau of Fisheries, Washington, D. C., upon appropriate blanks provided for the purpose. One form of blank covers shipments by mail, and the contents of each package must be certified on the blank by the postmaster. The other form of blank covers all shipments other than by mail. Care should be exercised to report on this blank all furs taken out as personal baggage.

A statement for the year ending November 15, 1913, based upon the reports referred to and the customs records, is embraced in the table below. This shows furs exported to the value of $678,062.91 as compared with $630,656.40 for the previous year, an increase of approximately $47,406.51 in the value of the so-called minor furs; that is, furs from Alaska other than fur seal and fox from the Pribilof Islands. The Pribilof furs are shown separately (p. 10) because taken by the Federal Government under special restrictions of law and therefore not a comparable factor in statistics showing gain or loss in quantity of catch taken by private persons or firms.

Among the approximate gains shown in furs other than from the Pribilofs are the following: Mink, $68,000; red fox, $38,000; blue fox, $19,000; white fox, $10,000; black fox, $4,000; muskrat, $4,000; black bear, $12,000; glacier bear, $2,000, and wolverine, $1,000. Among the losses there are: Marten, $89,000; silver gray fox, $16,000; land otter, $7,000, and ermine, $4,000. These variations are caused by fluctuations in values as well as by differences in the number of skins taken.

MINOR FURS SHIPPED FROM ALASKA IN 1912 AND 1913.[a]

Species.	1912			1913		
	Number of pelts.	Average value per pelt.	Total value.	Number of pelts.	Average value per pelt.	Total value.
Bear:						
Black	698	$7.50	$5,212.50	1,363	$12.57	$17,132.91
Brown	19	9.00	171.00	38	9.00	342.00
Glacier	5	15.00	75.00	111	22.50	2,497.50
Grizzly				12	40.00	480.00
Polar	9	40.00	360.00	72	40.00	2,880.00
Beaver	89	10.00	890.00	25	10.00	250.00
Ermine	7,957	1.36	10,821.52	6,559	.96	6,296.64
Fox:						
Black	3	600.00	1,800.00	24	253.00	6,072.00
Blue	502	45.00	22,590.00	892	46.59	41,558.28
Cross	603	17.00	10,251.00	768	14.24	10,936.32
Red	8,018	8.50	68,153.00	10,820	9.80	106,036.00
Silver gray	142	250.00	35,500.00	132	147.30	19,443.60
White	3,108	12.50	38,850.00	3,756	12.93	48,565.08
Hare, arctic	55	.40	22.00	49	.40	19.60
Lynx	2,720	21.50	58,480.00	4,772	12.35	58,934.20
Marten	12,999	12.50	162,487.50	9,682	7.56	73,195.92
Mink	31,363	4.50	141,133.50	47,062	4.46	209,896.52
Muskrat	123,925	.40	49,570.00	163,616	.33	53,993.28

[a] Neither the fur seal nor the fox skins from the Pribilof Islands are included here, being subject of special Federal administrative control and not the usual market conditions. For statistics of these, see p. 10.

MINOR FURS SHIPPED FROM ALASKA IN 1912 AND 1913—Continued.

Species.	1912			1913		
	Number of pelts.	Average value per pelt.	Total value.	Number of pelts.	Average value per pelt.	Total value.
Otter:						
Land	1,480	$14.00	$20,720.00	1,300	$10.70	$13,910.00
Sea	1	200.00	200.00			
Reindeer	4	1.00	4.00	5	1.00	5.00
Seal, hair	333	1.50	499.50	1,458	1.17	1,705.86
Squirrel	611	.08	48.88	34	.08	2.72
Wolf	103	9.00	927.00	163	7.00	1,141.00
Wolverine	189	10.00	1,890.00	242	11.44	2,768.48
Total value			630,656.40			678,062.91

TERRITORIAL TAX ON FURS EXPORTED FROM ALASKA.

The general revenue act of the legislature of May 1, 1913 (chap. 52), provides a tax upon furs exported from Alaska at the rate of one-half of 1 per cent of the gross value thereof, and prohibits any shipment of furs without first obtaining from the clerk of the court of the district whence the shipment emanates a license permit which must be paid for at the rate above specified. This act places additional duties and limitations upon various Federal officers not within the jurisdiction of the legislature, a proceeding declared invalid by the Attorney General of the United States; hence the proper execution of the tax law as it now stands seems most difficult or even impossible of accomplishment.

The portion of the act referring to an export tax on furs is as follows:

FURS: One-half of one per cent of the gross value of any furs, the product of Alaska, exported from the Territory and it shall be unlawful and punishable under this act for any person to ship from the Territory of Alaska any furs without having first paid for and obtained a license permit as herein provided; and no custom officer shall issue a manifest for nor postmaster receipt for mailing any furs unless the shipper thereof shall present a certificate for this license fee signed by the clerk of the district court of the division in which the furs were shipped.

PROPAGATION OF FUR-BEARING ANIMALS.

During the last year or so much activity has developed in Alaska in the propagation of fur-bearing animals, especially foxes. This activity has been stimulated by reports from eastern Canada, particularly Prince Edward Island, where fox raising is said to have made large fortunes for those engaged in the enterprise, and by the appearance of agents and representatives of fox-raising companies in New Brunswick and elsewhere, who have offered and paid what really seemed to be fabulous prices for live foxes to be taken east and utilized as breeding stock. There has been some competition, in consequence of which two or three breeders of blue foxes on islands

in central Alaska have received very satisfactory prices. Permits have been issued by the Secretary of Commerce for the exportation of live fur-bearing animals, and during the year 161 blue foxes, 24 silver-gray, and 10 cross foxes, or a total of 195, were shipped from Alaska.

Permits have not been issued for the exportation of wild stock but only to owners of fox ranches in Alaska for the shipment of domestic stock, i. e., animals that have been bred and reared in domestication. Permits are not transferable and are revocable at the discretion of the Secretary of Commerce. Only one shipment may now be made on a single permit, and it is required that holders of permits return them to the Bureau of Fisheries as soon as used, or upon the date of their expiration, as the case may be.

The policy regarding exportation of wild stock as breeders has, however, been under consideration with a view to possible change, and such exportation may be permitted another year.

Aleutian Islands Reservation.

The Aleutian Islands Reservation was established March 3, 1913, by the following Executive order:

EXECUTIVE ORDER.

It is hereby ordered that all islands of the Aleutian chain, Alaska, including Unimak and Sannak Islands on the east, and extending to and including Attu Island on the west, be and the same are hereby reserved and set apart as a preserve and breeding ground for native birds, for the propagation of reindeer and fur bearing animals, and for the encouragement and development of the fisheries. Jurisdiction over the wild birds and game and the propagation of reindeer and fur bearing animals is hereby placed with the Department of Agriculture, and jurisdiction over the fisheries, seals, sea otter, cetaceans and other aquatic species, is placed with the Department of Commerce and Labor.

It is unlawful for any person to kill any otter, mink, marten, sable or fur seal, or other fur bearing animal within the limits of Alaska Territory, except under such regulations as may be prescribed by the Secretary of Commerce and Labor; and it is unlawful for any person to kill any game animals or birds in Alaska or ship such animals or birds out of Alaska except under the provisions of law and under such regulations as may be prescribed by the Secretary of Agriculture.

Within the limits of this reservation it is unlawful for any person to hunt, trap, capture, wilfully disturb, or kill any bird of any kind whatever, or take the eggs of any such bird, except under such rules and regulations as may be prescribed by the Secretary of Agriculture.

Warning is expressly given to all persons not to commit any of the acts herein enumerated and which are prohibited by law.

The establishment of this reservation shall not interfere with the use of the islands for lighthouse, military, or naval purposes, or with the extension of the work of the Bureau of Education on Unalaska and Atka Islands.

This reservation to be known as the Aleutian Islands Reservation.

WM. H. TAFT.

THE WHITE HOUSE,
March 3rd, 1913.

To carry out the purposes of the Executive order, regulations for the administration of the reservation, to be mutually agreed upon by the Departments of Agriculture and Commerce, will be promulgated later.

LEASING ISLANDS FOR PROPAGATION OF FUR-BEARING ANIMALS.

During the year active steps have been taken by the Government with a view to the encouragement of fox farming in Alaska, and to this end announcement has been made by the Secretary of Commerce with respect to leasing certain islands in Alaska for the propagation of fur-bearing animals for a term of five years from July 1, 1914, at an annual rental of $200. Sealed proposals for the exclusive right to occupy said islands for this purpose will be received by the Secretary of Commerce up to noon of May 1, 1914. Details in regard to this matter were set forth in the following circular issued by the Secretary of Commerce under date of January 1, 1914:

PROPAGATION OF FOXES AND OTHER FUR-BEARING ANIMALS.

Announcement of the intention of the Secretary of Commerce to lease certain islands in Alaska for the purpose of propagating fur-bearing animals.

Paragraph 4 of the act entitled, "An act making appropriations for sundry civil expenses of the Government for the fiscal year ending June thirtieth, eighteen hundred and eighty, and for other purposes," approved March 3, 1879, provides—

"That authority be, and is hereby, given to the Secretary of the Treasury to lease at his discretion for a period not exceeding five years, such unoccupied and unproductive property of the United States under his control, for the leasing of which there is no authority under existing law, and such leases shall be reported annually to Congress."

Section 10 of the act entitled, "An act extending the homestead laws and providing for right of way for railroads in the District of Alaska, and for other purposes," approved May 14, 1898, provides that—

"The Annette, Pribilof Islands, and the islands leased or occupied for the propagation of foxes be excepted from the operation of this act."

An Executive order, dated February 2, 1904, is as follows:

"Upon the recommendation of the Secretary of the Treasury and the Secretary of Commerce and Labor, it is hereby ordered that the authority of the Secretary of the Treasury to lease certain islands in Alaska for the propagation of foxes, and all duties and powers pertaining thereto, shall be transferred to and be vested in the Secretary of Commerce and Labor."

1. The Secretary of Commerce will lease to the highest responsible bidders the exclusive right to propagate foxes and other fur-bearing animals on any or all of the following listed islands (which records show were leased prior to May 14, 1898, and that they are not now under lease) for a term of five years, at an annual rental of not less than $200 for each island. Every such lease shall be duly executed in triplicate, and will not be transferable.

Name.	Location.
Chirikof Island	Southwest of Kodiak Island.
Long Island	Near Kodiak Island.
Marmot Island	East of Afognak Island.
Simeonof Island	Shumagin Group.
Little Naked Island	One of Naked Islands, Prince William Sound.
Middleton Island	Gulf of Alaska.
Pearl Island	One of Chugach Islands.
Elizabeth Island	One of Chugach Islands.
Aghiyuk Island	One of Semidi Islands.
Chowiet Island	One of Semidi Islands.

2. No persons other than American citizens or companies or corporations organized under the laws of a State or Territory will be permitted by lease or otherwise to occupy the islands named herein for the purpose of propagating fur-bearing animals; and the Secretary of Commerce will vacate and declare any lease forfeited if the same be held or operated for the use, benefit, or advantage, directly or indirectly, of any persons other than American citizens or companies or corporations organized under the laws of a State or Territory.

3. The Secretary of Commerce will terminate any lease given to any person, company, or corporation upon full and satisfactory proof of the violation of any of the provisions of the lease or of the law and regulations for the protection of fur-bearing animals of Alaska on the part of the said person, company, or corporation.

4. Each lessee will be required to make detailed annual reports, in reference to his operations on the islands leased, to the Secretary of Commerce, on blanks furnished by the Department of Commerce, covering all such facts as may be required with respect to such operations for the information of the Department. Such reports shall be sworn to by the superintendent, manager, or other person having knowledge of the facts, a separate blank form being used for each island in cases where more than one island is leased by a person, company, or corporation.

Such reports shall be for the year ending March 31, and shall be forwarded to the Secretary of Commerce not later than April 30 of each year.

5. All persons, companies, or corporations holding any island by lease from this Department shall permit at all times free inspection of such island by the agents and representatives of the Department; and such agents and representatives shall have at all times free and unobstructed access to all corrals, pens, or other structures used for propagation operations thereon except at such times when the presence of persons other than the caretakers in or about the corrals, pens, or other structures would be recognized as detrimental to the welfare of the propagation operations.

6. The Secretary of Commerce will receive sealed proposals until 12 o'clock noon, on May 1, 1914, for the exclusive right to propagate foxes and other fur-bearing animals upon any or all of the islands named herein for a term of five (5) years from the first day of July, 1914, agreeable to the provisions of the Statutes of the United States.

7. The right is reserved to reject any and all proposals deemed to be not in accordance with the best interests of the United States.

8. As a guaranty of good faith, each proposal must be accompanied by a properly certified check drawn on a United States national bank, payable to the order of the Secretary of Commerce, in the sum of fifty dollars ($50) for each island named in the proposal. The check of the successful bidder will be retained and forfeited to the United States unless he execute the lease and bond required.

9. Proposals for leasing islands should be addressed to the Secretary of Commerce, Washington, D. C., and indorsed on the outside of the envelope, "Proposal for leasing an island (or islands) in Alaska for the purpose of propagating fur-bearing animals."

WILLIAM C. REDFIELD,
Secretary.

FOX BREEDING.

As previously stated, the Bureau is desirous of encouraging fox farming, especially on those Alaskan islands not productive in other respects, but suitable to an industry like this. The get-rich-quick possibilities, however, glowingly put forth with such strong appeal to the trappers, traders, and others in Alaska during the last year or two, have led to unfortunate ventures, which are much to be deplored and which might have been prevented by adequate understanding of the facts.

To the enthusiast the proposition has seemed all too simple. The black, silver-gray, and cross foxes are varieties of the red; the white fox is a variety of the blue. Starting with a pair of blacks or silver grays, or even a pair of reds, from which he was assured at least one or two blacks would be found in the first litter and would in turn breed true, it was easy for the prospective fox breeder to calculate that in the second year, or the third at most, there would be at least 10 good blacks or silver grays, 5 of which would be females, each to produce 8 to 10 pups the next year, and so on; and as blacks and silver grays were reported to be worth many thousands of dollars each as breeders, it was easy to compute the great and rapid gain and consequent wealth in a few years.

The fallacies in this reasoning are several. The desired blacks or silvers may not appear in the litter of the red fox. A pair of reds may not produce a black, or if so, only rarely. The blacks or silvers may not breed true; whether they will or not depends upon their own history. The fox breeder is not ordinarily in possession of the knowledge necessary to enable him to discover and interpret the facts in regard to his stock.

There is no inherent reason, however, why fox farming should not be a success in Alaska. Although on a number of islands various persons and companies have had such indifferent success that most of them have abandoned the undertaking, a few who have persisted are now getting fair profits. The reasons for failure seem to be chiefly these: Imperfect knowledge of the business or lack of experience; ignorance of elementary principles of animal breeding, and especially ignorance of the breeding, feeding, and other habits of foxes; turning the business over to unreliable keepers, with lack of personal supervision; difficulty in getting proper fox food; and great destruction of young by natural enemies, such as eagles. Perhaps the most serious difficulty has been the absence of intelligent supervision.

The factors to be considered in the business of fox raising, as in any other business enterprise, are the capital, operating expenses, and market prices of the product. Although the data at hand are meager, the Bureau offers the following suggestions:

Suggestions to Prospective Fox Breeders.

If one of the listed islands is leased, the minimum charge will be $200 per year, which would make $1,000 for the period of the lease, which is five years. Buildings should not be expensive. The cost of breeding stock will depend upon the number and kind of foxes with which operations are begun. Silver and black foxes at the present time command high prices. Breeders of these varieties can probably not be obtained for less than several hundred dollars each. A pair of red foxes will, however, occasionally produce one or more pups of these desirable color varieties. A person who has not sufficient capital to enable him to buy breeders of the choice varieties can start with a few pairs of reds, which are relatively cheap, and by selective breeding should be able in a few years to establish a strain of silver or black which will breed true. The man who pursues this method must be willing to wait several years for profits.

Operating expenses would vary with the accessibility of the island, the number of people employed, and the presence of natural food. There should be at least two persons on the island, although in favorable situations one caretaker may be enough. On some islands the foxes find sufficient food, while on others there is so little that practically the entire supply must be furnished from elsewhere. Salmon and other kinds of fish and whale meat are used.

No definite statement can be made as to the prices one may expect to obtain for fox skins. The blue fox skins taken on the Pribilof Islands in the winter of 1911–12 sold in London at an average price of $56.53 per skin. Of that lot, 28 choice skins from St. Paul Island (one of the Pribilofs) brought a little more than $131 each. At the sale at St. Louis, in December, 1913, of the fox skins taken on those islands in the winter of 1912–13, one lot of six blue-fox skins sold for $158 each. These are perhaps the best prices that blue-fox skins ever brought, and whether they will be maintained can not be predicted. With the large and increasing demand for all furs, however, there would seem to be no reason why fox skins should not continue to command good prices. Skins of silver-gray foxes have been sold at much higher prices than the above, and black-fox skins the highest of all.

In addition to the islands listed for leasing in the announcement, there are other unoccupied islands in Alaska available for fur farming, which could be obtained under the general land laws. There are several persons operating fox ranches in Alaska from whom breeding stock of blue, silver, cross, and black foxes can probably be purchased.

Notes on Fox Farms in Alaska.

The following data on fox ranches in various parts of Alaska have been furnished the Bureau by the wardens on duty in those regions:

Vicinity of Haines.—There has been much activity in fox farming in the vicinity of Haines during the past year. In the early part of August T. D. Lahey and Charles Handley of that place had in pens 31 young foxes ranging in age from three to five months. Among them were one black fox and five silver grays, the remainder being red or showing tendency to the cross variety. Mr. Lahey stated that when young they were all red, but as they grew toward maturity they acquired the silver gray phase. These foxes were captured in the country back from Haines.

When taken by steel traps the legs of the young foxes are sometimes quite badly injured, but nearly all recover. Two in the pens had deformed fore legs caused by the traps, but they seemed as active as the others. All were confined in pens of chicken-wire netting and were tame and playful and appeared to be in fine condition. They were fed once a day, in the morning, when each was given a ration of about a half pound of fish.

The pens at Haines were of a temporary character, pending the completion of more extensive quarters on the south side of the Chilkat River at the place known locally as Long Bridge, which is 18 miles out from Haines.

The permanent breeding inclosure now used, at the new establishment, consists of two rows of pens, 10 in a row, each pen being 30 by 40 feet. These two rows of pens face upon an inner range 40 by 300 feet. Surrounding all is an outer fence 350 feet by 180 feet. The fences extend 10 feet above ground and 3 feet below the surface; posts are set 10 feet apart. The walls of the fencing are of No. 16 gauge wire of 2-inch mesh, while the overhang, which is 2 feet wide, is of No. 18 gauge, with same size opening. From information at hand, it would seem that this is a well-ordered establishment.

Samalga Island.—An interesting report has been received from Mr. Samuel Applegate, of Unalaska, with reference to the propagation of blue foxes on Samalga Island, which is located southwest of Umnak Island in the eastern Aleutians. Samalga Island is $3\frac{3}{4}$ miles long and has an average width of one-fourth mile. It is low with a rocky reef-like formation running through it, and is quite heavily covered with grass. The shore runs bare from 250 to 400 yards around the whole island. This is the only island in the district upon which foxes have been placed for the purpose of breeding them for their pelts.

In the fall of 1897, Mr. Applegate first stocked the island with 13 blue foxes. They were allowed to run wild, and were not fed, as there appeared to be plenty of natural food. Two natives were employed during the winter months as watchmen.

The first foxes were killed in 1901, and up to and including 1912 the total number killed has been 570. During this period of 12 years, 3 years were allowed to pass without any killing, as the natives reported that the animals seemed to be scarce. At the time of killing in the winter of 1911–12 there were more foxes on the island than usual, and instructions were left with the natives to take up to 100 skins at the next season's killing, if they thought it safe. Of the 570 skins taken in the 12 years referred to, 546 were marketed.

The price of the fur fluctuates from season to season and depends upon the demand, which is determined by the prevailing fashion. The average price of fox skins from Samalga for the 12 years ending with 1912 is nearly $47, gross. The average price per year has ranged all the way from $22.48 in 1901 to $72.18 in 1912. Thus the gross return has been approximately $25,000.

As to conditions upon the island and the breeding habits of the foxes, Mr. Applegate states it as his opinion that during the first two or three years they increase at a rapid rate, but after that the rate is very slow. Litters run all the way from 4 to 14, with an average of about 8 at a birth. Casualties are high, it being estimated that on the average not more than two foxes from a litter reach maturity. It is more likely less than two. Mr. Applegate thinks in this connection that some of the matured vixens may prove to be wholly sterile, or perhaps bear young only part of the time. This peculiarity, he states, has been observed for some years past by fox breeders who make a specialty of raising silver foxes, and doubtless it holds good with blue foxes, and in fact with all foxes, even in a wild state.

Samalga Island has always appeared to be well adapted to foxes, which have the freedom of the whole island, plenty of natural food, and nothing to disturb them but the birds; yet it has seemed unsafe to take more than 50 or 60 pelts a season. The principal loss is caused by eagles, and to a less degree by ravens and even large sea gulls. While the young foxes a few days or a few weeks old are playing outside their burrows they fall easy prey to eagles and ravens. The natives say that when they find an eagle's nest in the vicinity of an island inhabited by foxes, the nest is a mass of little fox bones. Mr. Applegate has paid a bounty of 25 cents to natives for each eagle killed. From 1907 to 1911 they killed 583 eagles.

It is said that occasionally a mother fox will abandon her young when a few days old and they die of starvation. On Samalga Island an entire litter of very small foxes has been seen lying in a heap all dead, possibly abandoned by the old one, but it would seem more reasonable that the mother fox had lost her life and the young were thus left to perish. It is further averred that most female foxes if they get a good chance will kill the young of other females, especially when the young are very small.

Semidi Islands.—Perhaps the earliest attempt at fox raising in the region of the Kodiak group of islands was made by the Semidi Propagating Co. in 1885, when the Semidi Islands were stocked with blue foxes. About the same time this company also stocked Marmot, Whale, and Long Island with blue foxes, but for some reason all of these ventures have proved unprofitable. Marmot was abandoned some years ago; Whale and Long Island have produced nothing in recent years; and the Semidi Islands were without a keeper for three years until this winter, the number of foxes being so limited as not to warrant the expense of holding a watchman there continuously.

Chirikof Island.—Chirikof Island, about 70 miles southwest of Kodiak Island, is controlled by the Semidi Propagating Co., of which P. D. Blodgett, of Kodiak, Alaska, is manager. This island is 15 miles long and 3 miles wide, and, except for one hill, is low and flat and untimbered. It was stocked with blue foxes in 1891, and during the last five years has been a paying enterprise, producing annually from 50 to 60 skins, which have a market value of $50 or $60 each. Under Mr. Blodgett's management production has been restricted to the number here shown, which returns a revenue sufficient to meet the expense of maintaining three keepers on the island. Two years hence, at the expiration of his contract with the company as manager, a wholesale slaughter will be ordered; and if expectations are realized several hundred skins will be secured, as it is conservatively estimated that there are now 600 foxes on the island. By the terms of his agreement with the company, five pairs must be left on the island, and he believes it will be practically impossible to reduce the stock below that number in one season.

In one very important particular, this ranch is in a class by itself. It is self-supporting, which means that feeding is not necessary. Up to the present time the beaches have produced an ample supply of food, but should this fail the keepers are instructed to kill cattle, also raised on the island, for fox food.

The foxes are caught alive in box traps, thus making possible an examination of the fur before the animals are killed. In this way only prime skins are taken.

Ugak Island.—Ugak Island, off the east coast of Kodiak, near the entrance to Ugak Bay, was first stocked with silver gray foxes about 1891 by Oliver Smith, who three years later introduced blue foxes on the island. The two kinds of foxes did not thrive well together, for the natural enmity between them led to continual fighting, which finally resulted in the extermination of the blue ones.

Mr. Smith retained possession of the ranch for 10 years, but what degree of success attended his work has not been learned. About 11 years ago O. B. Anderson acquired possession of the island, and remained in control until the spring of 1912, when he presented the

property, with what few foxes were left, to his friend August Olson, of Kodiak, Alaska, who is the present owner. During the 11 years Mr. Anderson held the island it produced an average of 10 skins a year, having a value of something like $100 each. In April, 1912, he came to Kodiak with 20 silver gray fox skins, from which he expected to realize at least $3,500, values ranging from about $100 for the poorest to $500 for the best.

Though the beaches furnish a large part of the food of the foxes on this island, some feeding is required. For this purpose dried, salt, and fresh fish are used.

The island comprises an area of probably 600 acres, is comparatively high, and without timber except alder and birch brush. It and a small island off the west coast, near the mouth of Red River, claimed by Frank Peterson, are now stocked with silver gray foxes. These islands, because of the frequent and prolonged wind storms which prevail in the fall, can not be visited at that season without excessive cost.

Abram's Island.—About 10 years ago Abram Gregorioff, of Kodiak, began the raising of blue foxes on what is known as Abram's Island, which is located in Marmot Bay, a short distance from the northern end of Spruce Island. It has an area of about 400 acres, is high and well covered with spruce. Most of the shore is rocky and precipitous, a condition which is not favorable to the best results. Those who have given careful consideration to matters of this kind are convinced that the islands most suitable for fox raising have considerable beach area.

This ranch has produced only a few skins, probably less than 40 in the 10 years of its operation. The quality of the fur has been good, and in recent years the skins sold for approximately $50 each.

Where the foxes run at large, as they do on most of the ranches in this region, the number of animals on hand can not be definitely determined. An estimate of the number of foxes now on this island is placed at 8 or 10 pairs. Scarcity of food is the chief factor in retarding the development and productivity of this farm.

Noonyack Island.—Noonyack Island, situated about one-fourth mile north of Spruce Island, is occupied as a fox ranch by Abram Gregorioff, who placed thereon in 1898 one pair of blue foxes obtained from the fox ranch on Derinoff Island.

Since 1898 about 30 skins have been sold from this ranch, the values and dates of sale of which have not been obtained. In 1911, 3 male and 2 female live blue foxes were sold for $187.50, and in 1912 a pair was sold for $100.

The present stock on the island is estimated at 5 pairs, and the value of the property as follows:

Buildings, $1,100; vessels, $25; stock, $1,000; total, $2,125.

Hog Island.—Hog Island, which is located in Marmot Bay 3 miles east of the village of Afognak, has an area of about 50 acres and is comparatively low land, wooded with spruce. It was originally stocked with cross foxes by Christensen and Johanson in 1897 or 1898. Some three years later, silver grays were put on the island, but their introduction proved to be an unwise venture, for the consequent fighting between the two species brought about the extermination of both. The island was then stocked with blue foxes, and, in 1904, it was transferred to Alex Friedolin, of Afognak, to whom it now belongs. As a fox-raising establishment it has been virtually a non-producer. There is room for doubt whether it has even held its own, for losses by starvation and by theft have kept the stock reduced to or below the original number. If given proper care and plenty of food, a limited number of foxes can be successfully reared on this island, for its location is favorable in that it is far enough away from neighboring land to preclude the probability of any loss in that direction. It is a case of constant feeding, however, as the beaches contribute nothing in the way of food.

Last year Mr. Friedolin sold two pairs of live foxes for $110 a pair, and one skin from a fox that starved to death for $40. That was the banner year for Hog Island. He does not know how many foxes are left, but thinks there are not more than six or eight.

Dry Island.—Dry Island, stiuated near the west end of Kupreanof Straits, has an area of about 200 acres, is low, flat, and covered with scrub spruce.

In June, 1894, Charles Peterson and Charles Eckstrom, of Afognak, formed a partnership and settled thereon to engage in fox raising. These men still occupy this island. Their present investment is valued at $6,300 (buildings, $1,000; vessels, $300; and stock, $5,000). They do all the necessary work themselves and employ no special labor.

Their original stock consisted of one pair of silver-gray foxes from Nagai Island and one female silver-gray from Afognak Island. In 1896 they placed on the island two more female silver-grays purchased from M. L. Washburn, of Kodiak, but where these came from originally is not known to the Bureau. In January, 1901, four pairs of blue foxes from Derinoff Island and in September following six male and seven female blues from the same island were added. At the present time it is estimated that there are 25 pairs of blues on this island.

During the first 10 years of their work they tried breeding the silver-gray fox, but the wild, savage nature of this species made domestication unprofitable on such a small island. Some 10 years ago the silver-grays were killed off and blue foxes substituted. Since that time, by giving undivided attention to the business, their

enterprise has grown steadily until last year they were able to sell 18 pairs of live foxes at $110 a pair and several skins at substantially the same rate.

These men aim to keep at least 30 pairs of breeders on the island; and they have some wonderful breeders in their stock, too. Only last season two foxes produced a litter of 11 pups each, and reared them without the loss of one. Twenty-two foxes from two mothers makes the value of those two particular foxes far exceed the worth of their fur.

One noteworthy fact in connection with this ranch is that although the foxes run wild they are noticeably tame and to some degree have really been domesticated. Some of them have their dens or burrows under the outbuildings within a very few steps of the owner's dwelling, and it is no uncommon sight to see them running around the yard when strangers are not present.

This farm is one of those where constant feeding is necessary. Messrs. Peterson and Eckstrom salt from 6,000 to 10,000 salmon annually for fox food, and also do considerable line fishing for cod and other salt-water species which are fed fresh.

The success which these men have achieved in fox raising is attributed to the intelligent care and attention they have always given their animals, and their generous manner of feeding. Were it not for a liberal allowance of food they might experience a considerable loss on account of the proximity of Kodiak Island, to which their foxes would escape if food were not abundant.

Sales from this fox farm have been made yearly since 1902, when 15 blue fox skins were marketed at $17 each. In other years the prices have fallen below this figure only twice, and in 1909 50 skins were sold for $40 each. The highest price received was for three skins in 1912 at $50 each. In 1904, 1911, and 1912 live foxes were sold for $60, $70, $75, $110, and $100 a pair, some 25 or 30 pairs being sold during those years.

Alf's Island.—In 1904 Alf. Packirin, of Uyak, established a fox farm on a small island in Uyak Bay. This island, of about 40 acres in area and locally known as Alf's Island, is generally flat and covered with birch and cottonwood. The stock consists of about 30 blue foxes, which run wild on the island and are fed on fresh and dried fish. The annual output averages 12 skins, worth at the present time about $50 each.

Raspberry Island.—There are two fox farms on this island. The first of these is owned and operated by Ingwald Loe, who started in 1911 with two pairs of blue foxes.

In laying out the corral, a trench 2 feet deep was dug around a space 40 by 60 feet, and into this trench were set the posts to support the wire netting. The fence was made of 6-foot galvanized woven-

wire fencing, such as is commonly used around chicken yards. The lower edge of the wire was secured to poles laid in the trench, which was then filled with stones and earth. Thus far the fence stood 2 feet under ground and 4 above it. To the top of this wire was laced another piece of 6-foot fencing which was stretched around the inclosure, thus making the top of the completed fence 10 feet above the ground. Brackets nailed on the inside at the top of each post support a 2-foot band of fencing wire laid and fastened horizontally to prevent the foxes climbing over the fence. In like manner a partition fence was built across the inclosure, dividing the corral into two pens each 30 by 40 feet. Near the center of each pen a shallow hole was excavated into which a box about 2 feet wide, 2 feet high, and 10 feet long, with entrances cut in both ends, was built and covered with earth. One pair of blue foxes was placed into each pen.

Mr. Loe has since increased his corrals by building six more pens of the same size and construction, except that the outer fence is 2 feet higher, and has increased his stock by the addition of one pair of foxes.

His animals are very restless, continually running around the pens looking for a way of escape as most wild animals do when closely confined. Whether they will breed under such conditions is yet to be learned. This spring should supply the answer.

The other fox farm on Raspberry Island is on the north shore within a short distance of Loe's ranch and is owned by Charles W. Pajoman and Fred Larsensen of Afognak. They established their ranch in July, 1912, stocking it with blue foxes, two pairs each from Dry, Hog, and Noonyack Islands. One fox died and the skin was sold for $75. Their stock in October, 1913, consisted of five male and six female blue foxes. It is intended to increase the stock this winter by the addition of three pairs of blue foxes from Hog Island. The ranch consists of 12 corrals, each 30 by 40 feet, with wire fence 12 feet high, having an overhang at the top 2 feet wide.

On this ranch the male and female foxes are kept apart until just before the mating season.

The present equipment is valued as follows: Buildings, $1,000; stock, $550; vessels, $150; total, $1,700.

FUR-BEARING ANIMALS ON ALASKA PENINSULA.

Of the fur-bearing animals of the western Alaska Peninsula, land otter and mink are quite numerous. There are no marten in the region, and likewise no muskrats. There are not many ermine and but few are trapped. The lynx is but rarely reported and is not taken west of Chignik. There are practically no foxes save reds on the

peninsula and Unimak Island; occasionally a cross fox is found, but this variety is extremely scarce. About 20 years ago wolves were plentiful on the peninsula, and quite a number could be found on Unimak Island. Some 12 or 15 years ago, when prospectors began coming into the country, the use of poison resulted in the destruction of most of the wolves, and a great many foxes and wolverines were killed off. Wolves are now so scarce on Unimak Island and the western end of the peninsula that one would be regarded as a curiosity. During the winter of 1912–13 natives of Bear River killed two brown peninsula bears and one black bear. The latter kind is exceedingly rare in the region.

It is undoubtedly true that during the last decade the fur animals of the Alaska Peninsula have been much reduced in abundance, but it is confidently believed that not only will the depletion be checked, but that, through the rigorous application of present laws and regulations, there will be a notable increase. An augmented force of game and fur wardens and more frequent visits to the region in question are desirable, and, in fact, necessary to bring about this result.

In some of the western Alaska regions, notably along the southern shore of the peninsula, there is a disposition upon the part of the natives to disregard the fur and game laws, consulting as these natives do only their own pleasure and convenience in the matter, under the placid belief that any existing restrictions have been made for the whites alone. No exceptions are provided in favor of the natives, and every opportunity is being taken to correct the misapprehension under which they are laboring. It is an inherent characteristic of the natives to kill game whether or not they have use for it. For example, they have been known to kill food animals like caribou and leave the carcasses where they fell without any pretense of using them. This practice is to be condemned and deprecated from every point of view, and earnest effort must be made to implant in the mind of the native a proper appreciation and understanding of the harm resulting from such wanton destruction of animal life.

Some of the trappers of the Alaska Peninsula region would like to have the open season for foxes extended in the spring two weeks after the present closing date of March 1. They claim that the fur is prime until this date, and that they would rather have the season lengthened in the spring and shortened in the fall, for during the latter period the fur is less apt to be prime. An extension of the spring season is undesirable, as it would lap over into the breeding season.

Some six or seven years ago Radion Duskin, a trader of Belkofsky, put a few red foxes on Dolgoi Island, a good-sized island south of the peninsula and to the eastward of Belkofsky, and now claims ownership of all furs on the island. It is stated that the Russians introduced silver-gray foxes there in their time, and that there are now

some cross foxes to be found. The island is also the home of a considerable number of land otter.

Deer Island is trapped by everyone who cares to go there. The Russians put silver-grays there, and now a few cross and red foxes are on the island, with very rarely a silver. On Ukolnoi Island there are a few red foxes and land otter. No one claims title to the furs, and the animals are trapped by anyone who cares to go after them. On Tigalda Island, west side of Unimak Pass, there are some silver gray and a few cross foxes; also there are a few on Akun and Akutan Islands.

It is said that natives from Belkofsky have stocked the Iliasik Islands, opposite that town, with red foxes, where there were none before, and now claim all the furs of those islands. There are said to be no other fur animals on the Iliasik Islands, and so far everyone has respected the claims of the natives to the stock placed there.

FUR-BEARING ANIMALS OF THE AFOGNAK-KODIAK REGION.

The species of fur animals in this region are the sea otter, land otter, fur seal, silver-gray fox, cross fox, red fox, creole fox, ermine, and brown bear.

Sea otter.—This valuable and interesting animal is said to be generally distributed throughout the waters of the Afognak-Kodiak region, but is now very scarce. Formerly it was quite abundant, and large catches were made, particularly to the westward in the vicinity of the Sannak and Shumagin Islands. The fabulou ly high prices which the skins command have caused the sea otter to be hunted most relentlessly, until the species has nearly reached the point of commercial extinction.

Realizing the danger of actual extermination, the Department, in 1910, established a close period for the sea otter until November 1, 1920. This prohibition, however, applied only to Territorial waters, the United States having no jurisdiction beyond the 3-mile limit. On the high seas the sea otter had no protection. Citizens of the United States could hunt it anywhere outside the 3-mile limit. So could the citizens of British Columbia, Japan, or any other country; and many did so, particularly the Japanese.

Fortunately, the fur-seal treaty of July 7, 1911, signed by the United States, Great Britain, Japan, and Russia, contains a clause making it unlawful for the subjects of any of the nations signatory to the treaty to "kill, capture, or pursue beyond the distance of 3 miles from the shore line of its territories sea otters in any part of the waters mentioned," that is, "in the waters of the North Pacific Ocean north of the thirtieth parallel of north latitude, and including the Seas of Bering, Kamchatka, Okhotsk, and Japan." This treaty is now in force, and it is therefore unlawful to kill, capture, or pursue

sea otter anywhere in Alaskan waters or in the waters of the North Pacific. It is hoped that enough individuals are left to reestablish the species and that in time it may again become so abundant as to permit a large annual catch.

Rumors have been heard to the effect that last winter some of the Sannak Island natives hunted sea otter, but owing to the present law they let the skins go for a mere pittance. It has also been intimated that under the guise of cattle raising there has been netting of sea otter about the Sannak Island reefs, even to the extent of moving some of the cattle to Caton Island, which is more favorably situated in some respects for sea-otter hunting, in order to keep people in ignorance of the real purpose in view.

The Department has not been aware of any violations of the law as rumored, but hereafter vigilant watch will be kept of this region, and any persons caught hunting or killing sea otter will be prosecuted to the fullest extent of the law.

Early this year the idea became prevalent in the Kodiak region that it had become lawful for natives to kill sea otter with bow and arrow, and that a special tag had been prepared to be attached to all skins taken in this manner. This idea was, of course, entirely erroneous, for the killing of sea otter is absolutely prohibited in the Territory of Alaska, in the waters thereof, or on the high seas by any person subject to the jurisdiction of the four countries named in the convention of 1911. The impression regarding a special tag for sea-otter skins probably arose from some misunderstanding in connection with the tags prepared for attachment to fur-seal skins lawfully taken on the high seas by Indians, Aleuts, or other aborigines dwelling on the coast of Alaska.

Land otter.—The land otter occurs on Afognak and probably on all of the adjacent islands. It was formerly a rather abundant animal and, by some reports, is still quite common. One person reports it as holding its own; another as fairly plentiful; another as plentiful on Shuyak Island, scarce on Spruce Island, not very plentiful on Kodiak, but more so on Afognak, and scarce on the smaller islands; still another says it is getting scarcer; and another, one of the best trappers on Kodiak Island, reports that the supply is growing less. The land otter seems to have few enemies except man.

During the past two years Inspector Ball has traveled extensively over Afognak Island and has given much attention to the abundance of the various fur animals. In a report made in November, 1913, he regards the land otter as the most abundant and most valuable fur animal of the Afognak Reservation. Its tracks were found along the shores of every lake visited and in several places on the ocean beach.

The land otter is said to breed in this region in May in holes or burrows in the banks or near streams or lakes, and to have an average

of six young in a litter. The young are said to follow the mother, often traveling great distances, even crossing Shelikof Straits.

Considerable divergence of opinion exists as to the period during which the pelts are prime. One person says from November 1 to April 1; another, November 16 to April 1; another, November 1 to March 1; another, December 1 to March 1; while another says only in the winter months, December, January, and February. One dealer states that when trapping began in October the percentage of unprime skins was very high.

The land otters were very seriously affected by the volcanic ash thrown out by Katmai Volcano in the eruption of June, 1912. So seriously were they injured that many of the skins taken in the winter of 1912–13 were worthless. Just how the ash affected the fur is not fully understood. The fur looks as if the animal had been sheared and the little fur remaining is matted and tangled like sheep's wool. The only part of the pelt not seriously affected is a narrow strip along the middle of the back. The parts most affected are the belly and the lower parts of the sides, which suggests that the injury was caused by the cutting of the volcanic ash when the animal was traveling through or sliding over it. It is the opinion of Mr. Ball that the injury done to the land otters of that region by the volcanic ash is very serious. Many of the skins taken in the winter following the eruption were worthless as fur, while all showed more or less wear which was believed to have been caused by the ash.

In view of these facts and upon the recommendation of Mr. Ball, the Department, on October 29, 1913, issued an order establishing a closed period for land otters in the Afognak Reservation until November 16, 1915.

Fox.—In the Afognak region foxes are said to be most abundant on Kodiak Island, though they occur in some numbers on Afognak and neighboring islands. They were formerly common on Shuyak Island, but all were poisoned about 5 years ago and probably none is found there now. The common fox of the region is, of course, the red fox, with a proportion of the various color phases known as silver, cross, and creole foxes.

The general opinion is that foxes are becoming scarce on these islands. The silver fox is said to be very rare and the cross scarce.

The volcanic eruption already referred to seems to have affected the foxes seriously. Perhaps half the skins taken in the winter of 1912–13 showed spots about the size of a man's hand just over the rump, where the fur was much worn. Practically all the skins so injured were taken in the northern part of Kodiak Island. The injury to the skins was so great as to seriously impair their value.

The foxes on Afognak Island were nearly all exterminated. In extended trips over the island made by Mr. Ball in the summer of

1913 the track of only one fox was observed. Only one fox was captured in the previous winter. In view of these facts the Department, on October 29, issued an order establishing a close period for foxes in the Afognak Reservation until November 16, 1918. The order is as follows:

REGULATIONS FOR THE PROTECTION OF FUR-BEARING ANIMALS IN THE AFOGNAK RESERVATION, ALASKA.

[Department Circular No. 252, Bureau of Fisheries, Alaska Fisheries Service.]

To whom it may concern:

On account of the scarcity of foxes and land otters in the Afognak Reservation, caused largely by the recent volcanic activities in that region, it is hereby ordered that the pursuit, capture, or killing of foxes in the Afognak Reservation shall be unlawful until November 16, 1918, and the pursuit, capture, or killing of land otter in the Afognak Reservation shall be unlawful until November 16, 1915.

WILLIAM C. REDFIELD,
Secretary.

The mating season for the foxes in the Afognak region begins in March and the young are born in May or late April. The dens are usually under roots of trees or in holes or crevices in the rocks, wherever suitable openings can be found. The number of young may vary from 3 to 14, the average being 6 or 7. One fox was killed at Uganik that contained 11 unborn young. One was killed on Long Island that carried 14 young. The natural food of the foxes in this region consists of fish, birds, small mammals, mollusks, sand fleas, and other crustaceans, and such other animal material as can be picked up along the shore. They doubtless are quite destructive to ptarmigan and other ground nesting birds and to shrews, mice, and other small mammals. They will eat almost any kind of meat, and no inconsiderable portion of their food is furnished by the carcasses of various marine animals which wash up on shore. It is said that an experiment was conducted by the Semidi Propagating Co. for the purpose of determining the best artificial food. They tried various kinds, weighing the food and the foxes daily, and reached the conclusion that dried fish is the best artificial food. It is generally believed that the female carries food to the young, and that the male will kill and eat the young when food is scarce.

Among the enemies of the foxes, eagles are perhaps the worst. Next to them come ravens and sea gulls. When the young foxes are from a few days to a few weeks old, and begin to play about their burrows, the eagles and ravens swoop down upon them and carry them off to eat or feed to their young. Even the large sea gulls will sometimes pick up young foxes and carry them off. Mr. S. Applegate, who has for many years operated a fox farm on Samalga Island, is of the opinion that the natural mortality among young foxes is 65 to 75 per cent.

In the Afognak region the fur of the foxes is prime in December and January only, according to one dealer. Another says from November 1 to April 1; another, from November 16 to March 1; and still another, during December, January, and February. The present regulation provides an open season from November 16 to March 1, which seems to meet the conditions fully and the approval of the trappers and dealers.

The usual method of capture is by means of steel traps and "klipses," a Russian device, set in the trails. This method is practiced until the snows become heavy; after that a favorite method is still hunting on moonlight nights.

Ermine.—Ermine, or weasels, are found on all the islands of the Afognak region. Formerly they were very plentiful, but they are becoming more and more scarce every year. About the villages, where even the children do trapping, they are most rare. In the less frequented parts of the islands, particularly along the streams and shores, they are still rather common. There seems to be great irregularity, however, in the abundance of these little animals, just as there is with rabbits; one year they may be very numerous, the next year very scarce, and the next year abundant again.

The weasels feed chiefly on birds such as ptarmigan, sparrows, pine siskins and redpolls, and mice, shrews, fish, and any other flesh they can get. They are said to store their food. They breed in April and May and produce 4 to 7 young. The usual methods of capture are by means of figure-4 traps and deadfalls.

The present open season, November 16 to March 15, appears to cover properly the period during which the fur is prime.

Brown bear.—The brown bears of Afognak and neighboring islands are classed as game animals by the Alaska game law. As they are also fur-bearing animals their consideration in this report is proper. Brown bears are found in considerable numbers on Kodiak and Afognak Islands, and probably a few occur on Raspberry and Shuyak Islands. The species on Kodiak is the one known as *Ursus middendorffi* Merriam. Probably it is the same species found on Afognak, Shuyak, and Raspberry Islands, but this is not known to be the fact. Very little appears to be known about the breeding habits of these big brown bears. Some of the Afognak hunters claim that they breed at any time. No one could be found who claimed to have seen one of these bears carrying unborn young. Some hunters think they have three cubs at a litter, but sometimes fewer, and that they do not breed every year.

Their food consists chiefly of fish, roots, and berries. They go into hibernation in December, several occupying one hole, and do not come out until in March or early April.

The pelts are in prime condition from November 15 to May 31.

Hunters and Trappers.

A list of the hunters and trappers of the Kodiak-Afognak region would include practically every native man and every boy over 12 years of age, for they all hunt and trap more or less each season. A list compiled in December, 1912, contained 223 names, classified by localities as follows:

Ousinka settlement, Kodiak post office	21
Karluk trappers, Uyak post office	34
Uganik trappers, Afognak post office	9
Little Afognak trappers, Afognak post office	11
Afognak trappers, Afognak post office	93
Kodiak trappers, Kodiak post office	6
Wood Island trappers, Kodiak post office	13
Eagle Harbor and south, Kodiak post office	36
Total	223

The general opinion is that these people as a rule have no scruples about hunting or trapping out of season, and they will do so if they think they can avoid being caught. They were in the habit of going into the field with their guns and traps several days before the season opened, ostensibly to build or repair barabaras, but in reality to hunt foxes and land otters.

Since the Department now has a representative stationed at Afognak who acts as fur warden, conditions have much improved.

When the open season begins each trapper will put out 10 to 50 traps for foxes and land otters, and perhaps as many more for ermine. After heavy snows have fallen, trapping is abandoned because the alternate thawing and freezing covers the traps with ice, so that they will not operate. Trapping then gives way to hunting, which continues with varying interest until the end of the season. At first the trappers manifest considerable energy and enthusiasm and give faithful attention to their traps; but after two or three weeks their zeal languishes and they return to their homes, leaving their traps set and without attention for several days. During these intervals of neglect, animals are caught, die in the traps, and the skins become ruined either through decay or the attacks of bears and eagles.

Some of the trappers sell their furs for cash; others trade them for groceries and clothing; while still others hypothecate their catch for provisions and then, forgetting who grubstaked them, sell where they can get the best price. Nearly all the skins are sold as fast as caught. There were, in 1912, three principal buyers at Kodiak and three at Afognak.

Some idea of the importance of the Afognak-Kodiak region as to fur production can be gained from the following statements:

One firm at Kodiak in the season of 1911–12 handled 27 land otters, 122 ermine, 18 cross foxes, 24 red foxes, 5 silver foxes and 2 wolverines, the latter from the Kenai Peninsula.

Another dealer at Ousinka in the season of 1910–11 handled 2 silver and 4 red foxes, 1 land otter, and 400 ermine; in 1911–12, 1 silver and 6 red foxes, 2 land otters, and 389 ermine.

A dealer at Afognak in 1911–12 handled 16 land otters, 2 silver and 25 red foxes, 112 ermine, 17 mink, and 2 wolverines.

Another Afognak dealer handled in the season of 1911–12, 201 ermine, 35 land otters, 7 mink, 10 cross, 2 blue, 2 red, and 2 silver foxes.

The total shipments for the season of 1912–13 from the Afognak-Kodiak region for which the Bureau has reports were as follows:

Ermine	321
Fox, blue	89
Fox, black	3
Fox, cross	95
Fox, red	350
Fox, silver	27
Otter, land	162
Wolf	1
Wolverine	4

FISHERY INDUSTRIES.

By WARD T. BOWER and HARRY CLIFFORD FASSETT, *Assistant Agents.*

As in similar reports for previous years, the Territory of Alaska is here considered in the four coastal geographic sections generally recognized as follows: Southeast Alaska, embracing all that narrow strip of mainland and the numerous adjacent islands from Portland Canal northwestward to and including Yakutat Bay; central Alaska, the region on the Pacific from Yakutat Bay westward, including Prince William Sound, Cook Inlet, and Chignik; western Alaska, the shores of Bering Sea, tributary waters, and the islands in Bering Sea; and Arctic Alaska, all that portion of Alaska facing on or tributary to the Arctic Ocean.

In the following pages are given not only detailed reports and statistical tables dealing with the various fishery industries, but there are presented also the salient features from reports on certain subjects which were the objects of special investigation or inquiry.

TERRITORIAL LEGISLATION.

The act of Congress of August 24, 1912, created a Territorial legislature for Alaska, and the first session of this body occurred at Juneau during the period of 60 days ending May 1, 1913. The enabling act conferred upon the legislature various powers and duties, and at the same time imposed certain limitations, among which was the proviso, in substance, that the authority granted the legislature to alter, amend, modify, and repeal laws in force in Alaska should not extend to fisheries laws nor to the laws of the United States providing for taxes on business and trade. In reference to the matter of revenue it was further provided that all taxes shall be uniform upon the same class of subjects, and shall be levied and collected under general laws, and assessments shall be according to actual value thereof.

FISHERY TAXES.

Under the authority which it was assumed Congress had granted in the enabling act the Legislature of Alaska passed a general revenue measure which so far as it affects the fisheries provides—

For a tax of 7 cents per case on red and king salmon and one-half cent per case on cohos, pinks, and chums, this in addition to the Federal tax of 4 cents per case on all species of salmon.

That one-half of the additional or Territorial tax on canned salmon should be kept in the Territorial treasury to be expended under direction of the Bureau of Fisheries in the preservation and propagation of fish.

Cold-storage plants handling fish are taxed from $10 to $500 per annum, according to the amount of business done.

Fishing vessels of 30 tons or more net register are taxed at the rate of $1 per ton annually.

There are several other features more or less directly affecting the fishing industry, including the tax of 10 cents per ton on freight shipped into or out of the Territory, the employers' liability act, and the poll-tax measure. No attempt was made to tax fishing gear.

The clerk of the United States court is made ex-officio tax collector, and the act imposes various duties on other Federal officers, including fisheries agents and their deputies.

All of this legislation has been challenged by the fishing interests. The intention of Congress is apparently clear that the Legislature of Alaska shall have no jurisdiction in the matter of fishery laws, except possibly as regards taxation. In reference to taxation the language is not altogether conclusive. The clause in the enabling act referring to laws of the United States providing for taxes on business and trade evidently refers to section 460 of the act of May 3, 1899, as amended by section 29 of the act of June 6, 1900, which was undoubtedly enacted for the sole purpose of raising revenues for the Government and in no way for the purpose of regulating the various enterprises enumerated and taxed. In other words, it is purely a revenue measure. By the act of January 27, 1905, the revenues collected under that law were covered into the Alaska fund.

The act of 1912 prohibits the legislature from in any way altering, amending, modifying, or repealing the act creating the Alaska fund, as well as laws enacted for the purpose of contributing to that fund.

Cognizance must be taken, however, of what may perhaps be properly considered as a conflict in the language of section 9 of the enabling act providing for uniform tax measures upon the same class of subjects, and that assessments shall be according to actual values.

The controversy aroused by this legislation has not yet been settled. Upon one feature of the law only has opinion been rendered, namely, that concerning collection of taxes by Federal officials. The Attorney General of the United States has recently declared this feature of the Territorial act null and of no effect, since Section II of the enabling act provides that no one holding a commission as an officer of the United States in Alaska shall hold any office under the Territory.

The Territorial revenue measure did not become operative until 90 days after its passage on May 1, hence practically all of the pack

of red salmon in the Bristol Bay region, as well as a good share of the entire pack of all species in Alaska, was completed this season before the tax measure became effective. At least one company has already paid the new Territorial tax on this season's business.

POLLUTION OF WATERS.

An act of the legislature which has a direct and considerable bearing upon the fisheries question is that prohibiting the pollution of certain waters by means of sawdust and other lumbering waste. This is an excellent measure which ought to be enforced diligently, as there is no doubt but that sawdust is very destructive to fish life, particularly when it is deposited in waters where it will settle upon spawning grounds. This measure is in line with similar acts now effective in many of the States.

ALIEN FISHERMEN.

The legislature passed a bill to prohibit the taking of fish, whales, or other marine animals in Alaska waters by aliens. On the last day of the session, Gov. Walter E. Clark vetoed this measure on the ground that it was not within the province of the legislature to act in the matter. Gov. Clark's veto message sets forth in very able manner certain facts affecting vitally the fishery matters in their relation to the Territorial legislature, and in connection therewith the following excerpt from the message is herewith reproduced:

> So far as the fisheries are concerned the subject of this bill is not one for the Territory, but for the Nation; and so far as the interests of aliens are affected, the matter is peculiarly one for the Nation, because of its international character. Thus two very strong reasons are interposed, either of which alone would make it impossible for me to join in the passage of the bill.
>
> It is a popular notion that the Alaska fisheries belong to the Territory, but they will not belong to the Territory prior to statehood. The doctrine that the fisheries in navigable waters of the coast belong to the sovereign power was established even prior to the independence of the United States. The control of the fisheries which are not within the State waters belongs, therefore, to Congress, and this control has not been delegated to the Territorial Legislature. Indeed, it is specifically provided in our enabling act that "the authority herein granted to the legislature to alter, amend, modify, and repeal laws in force in Alaska shall not extend to the * * * fish * * * laws." The act of June 14, 1906, the provisions of which are distinctly modified by this bill, is one of the principal fishery laws passed by Congress for this Territory. It is wrong from every point of view to pass a bill in violation of the enabling act on the theory that Congress will not affirmatively disapprove it. Besides, the probability of such inaction by Congress in the present case does not exist.
>
> The first Legislature of Alaska ought not deliberately to pass an act calculated to embarrass the Federal Government in its international relations, and such an action is not worthy of our better judgment and of our trusteeship of legislative authority and power granted by the Nation for the people of the Territory. If this bill provided for the exclusion of aliens from our boundaries, no person would question the gravity of the action, even if authorized by the Congress of the United States. Yet the bill

does undertake to exclude aliens from participation in a great industry; and the effect is not far different. I appeal to the legislature to refrain from finally passing an act which, in all probability, would be rejected on the broadest grounds of national and international interest if presented in the Congress itself.

No effort was made to pass the alien measure over Governor Clark's veto.

FISH-TRAP CONTROVERSY.

Early in the session of the legislature, and notwithstanding the seemingly direct prohibition in the enabling act, Delegate Wickersham, who represented Alaska in Congress, took the stand that the Territory had authority to legislate in all matters pertaining to the fisheries of Alaska. As a result of this opinion, bills were introduced in both branches of the legislature to prohibit the use of fish traps in Alaska waters, and a heated discussion was precipitated, which soon resolved itself into a controversy between trap fishermen and purse-seine fishermen. Various hearings were held by the joint fisheries committee of the two houses, at which representatives of both sides were heard at length.

Action was deferred in the hope that an opinion could be obtained from the Attorney General of the United States as to the legislature's authority in the matter. No opinion was received, but the general view entertained by legal authorities is that the Legislature of Alaska had no jurisdiction. Near the close of the session the antitrap bill was called up in the senate and met with defeat.

Failing to effect the passage of the antitrap bill, the legislature then memorialized Congress as to what it considered best for the Territory in the way of fisheries legislation. Following is an outline of the memorials:

For Government ownership of hatcheries.

For patrol to prevent encroachment of alien halibut fishermen.

That herring and other food fishes be not used for oil and fertilizer after 1917.

To rescind the order creating the Aleutian Islands Reservation.

That returns from seal fisheries and sale of public lands be applied to road fund.

To abolish jiggers on fish traps; limit lead on traps to 600 feet; limit traps to a distance of 1 mile from streams; remove traps from channels less than 1 mile in width; the Bureau of Fisheries to establish markers at stream mouths, places to be designated by practical fishermen; the Government to operate all hatcheries; that the inspection system affecting fishing operations be expanded; condemnation of general features of the Jones bill, particularly with reference to creation of Alaska fund; objection to any law granting title to tide lands or waters, or making special reservations for fishing any certain kind of gear; prohibition as to taking salmon by spear or gaff for commercial use; establishment of close season for southeast Alaska on ed and humpback salmon September 1 to December 1.

Much opposition developed to some of the proposed fishing limitations, the contention being that it was drawn especially to favor the interests of the purse-seine fishermen, and that it was unfair to the owners of fish traps. Practically all of the discussion and

activity regarding fishery matters before the legislature centered in and had bearing upon the fish-trap and purse-seine controversy.

It will be remembered that the purse seine is a greater employer of labor than the trap, hence the advocates of the purse seine are strong numerically. It is the cannery owners who operate chiefly the more expensive trap, and the question thus becomes a dispute between capital and labor. The cannery men maintain that the sweeping abolition of their most economical form of gear would be confiscatory and ruinous to an industry having millions invested in the Territory; that it would react with greatest force upon those advocating it; that traps insure a fresher and better quality of fish; and that the plea of the purse-seine fishermen that traps are destroying the runs of salmon is not borne out by fact or statistics. It is upon the score of killing excessive numbers of salmon that the friends of the purse seine denounce the trap.

To have the benefit of impartial opinion in the controversy, Governor Clark, at the instance of a member of the legislature, asked the Secretary of Commerce to send a representative of the Bureau of Fisheries to appear before the legislature. The Secretary accordingly directed Assistant Agent Bower to proceed to Juneau and lend every proper effort toward an understanding of any and all fishery matters to which the legislature might desire to give consideration.

Since the trap and purse-seine question is a very important one, and as there may be future use for certain facts in relation to it, some of the testimony given before the joint fisheries committee, and the general attitude of the Department in the matter, may with propriety be repeated here.

It is important to realize at once the two-fold nature of the question. The purse-seine fishermen protest against the trap, which is a labor-saving device and economy to the cannerymen, upon the ground that it is dangerous to the supply of fish. An employer's right to use labor-saving devices can not, for itself alone, be successfully assailed. The public rights in natural resources, on the other hand, can and should be protected. The burden of proof, however, seems to rest upon the purse-seine fishermen, who must show that the trap is a wasteful or monopolistic mode of capture.

It is unanimously agreed that, except a safe breeding reserve, all the fish our waters will yield may very properly be taken for economic uses. It is also unquestionably proved, by the history of the fisheries the world over, that any appliance for wholesale capture may exhaust the supply if operated without regulation. For the preservation of the supply of fish, therefore, it is necessary to limit the catch. This may be accomplished (1) by the use of an easily controlled form of fishing apparatus; (2) proper close seasons; (3) restriction of fishing areas as necessary; (4) limiting distance inter-

vals between apparatus; (5) limiting or prohibiting fishing in streams; (6) licensing of fishing gear; (7) adequate provisions for enforcement of the law.

Every type of apparatus must, of course, be operated under certain restrictions adapted to its character. There are two general classes of fishing gear, namely, fixed and mobile. The one awaits the coming of the fish, the other seeks to follow the fish in their movements. In the first-named class is the trap. In the second is the purse seine. These two forms of gear operate in Alaska under the following restrictions:

Fixed gear: It is prohibited to build a trap (1) in any stream or channel less than 500 feet in width; (2) within 500 yards of the mouth of any red-salmon stream less than 500 feet wide; (3) in any stream or channel of over 500 feet wide for more than one-third the distance across it; or (4) in any place within 600 yards laterally or 100 yards endwise from any other fixed fishing appliance (laterally obviously means sidewise; that is, along the shore).

Seines and other movable gear: It is prohibited (1) to set any seine for a distance greater than one-third the width of any stream, estuary, or lagoon (practically the same as applies to the trap, except the trap can not be put in waters less than 500 feet wide; the seine can be used there so long as it does not sweep the channel for a distance greater than one-third its width); (2) within 100 yards outside the mouth of any red-salmon stream where the same is less than 500 feet in width; (3) to operate any seine or other appliance within 100 yards of any other seine or fishing appliance.

It will be noted that for red-salmon streams less than 500 feet wide, a trap must remain at least 500 yards away from the mouth and a seine only 100 yards away, a difference of 400 yards in favor of the seine.

Following are statistics of gear used in 1911: In all Alaska there were 263 seines, 1,734 gill nets, and 152 traps. In southeast Alaska, the section most concerned in the present discussion, there were 91 traps which caught 9,341,136 salmon, or an average of 102,649 per trap. In the same region there were 227 seines which caught 17,149,869 salmon, or an average of 75,546 per seine. The surprising feature of these seasonal figures is that on the average the catch of each purse seine was within 27,000 salmon of the catch of each trap. But as there were many more seines than traps the total catch by seines was nearly double that of the traps.

The foregoing figures are for the season of 1911. During 1912 the total catch in Alaska by means of traps was 19,921,000 salmon, while all other forms of gear combined caught 41,020,000. This is 32 per cent for traps and 68 per cent for the other kinds of apparatus, and makes a total catch of more than 61,000,000 salmon in Alaska during 1912.

In southeast Alaska in 1912 there were 346 seines which caught 14,728,000 salmon, an average of 42,566 each; 377 gill nets which took 767,000 salmon, or an average of 2,034 each; and 176 traps which took 13,885,000 salmon, or an average of 78,892 each. We note that the catch by traps, comparing the two years 1911 and 1912, drops on an average from 102,000 to 78,000, and the catch in the case of seines declined from 75,000 to 42,000 on the average.

For the purpose of comparison, the figures for seines in 1912 are not of great use for the reason that most of them operated only part of the season because of the strike. It is only fair to say that on the average the seines fished only half of the season of 1912. But even so, the seines in southeast Alaska caught about a million more salmon than the traps. It is significant to note that the average for traps fell from about 102,000 in 1911 to less than 79,000 in 1912. A possible reason for this exists in the fact that in the scramble for traps in 1912, many sites were tried which proved to be poor.

The total amount of fishing gear used in Alaska, aside from lines, during 1912 was: 413 seines, an increase of 150 over 1911; 273 traps, an increase of 121 over 1911; and 1,954 gill nets, an increase of 220 over 1911. Of the increase of gear by sections, the most notable was on traps in southeast Alaska, where the number rose from 91 in 1911 to 176 in 1912.

In considering the question of depletion of waters, it is not proper to select any individual stream or any particular year as a basis for final conclusions. There are offyears and variations and fluctuations just as in the case of crops raised by the farmer. Tides, ice, and winds may influence the movements of salmon.

The problem in the perpetuation of the fishery is to determine the escape of breeding salmon necessary to keep up the supply, and since 1908 the Department has been conducting an elaborate system of actually counting the number of brood salmon escaping the fishermen's nets and passing up Wood River, a tributary to Bristol Bay. The idea is to correlate the escape with future returns and thus fix a definite limit upon the number that may be taken for commercial use. A continuance of these investigations is necessary for a few years longer before definite conclusions can be drawn, but important facts are already available as to what a region will stand in the face of heavy trap fishing.

For years the lagoon at Chignik has been studded with a network of from ten to fifteen or twenty traps, some of them with leads several thousand feet long. Notwithstanding the apparent impossibility of any fish passing this network of traps, it may be said that during 1911, when the Government made an exploration of the region, not only did the traps farthermost upstream fish quite well, but also there were evidences of what appeared to be a good escape to the

spawning grounds above, a very remarkable condition. Chignik has not had the benefit of any hatchery support.

It is hardly to be conceived that trap fishing will ever deplete the waters of Cook Inlet, especially since traps and all commercial fishing for salmon have been barred in the tributary streams. The waters of the inlet are very turbid, and it is well established that the fish do not follow any particularly defined course. Good catches have been made by gill nets several miles offshore.

Traps extend out into a channel but a comparatively short proportion of its width, therefore large numbers of fish have ample opportunity to pass unobstructed. In some places the fish strike in toward the shore much more freely than at other points, hence certain spots are recognized as better trap sites than others. But there is ample proof that great quantities of salmon travel away from the shore line. Specific places may be cited, as, for example, Nushagak Bay, where fishing covers all sections of the channel, which is several miles wide. In southeast Alaska the fact that considerable numbers of salmon are caught in movable forms of apparatus far outside the range of any traps is good evidence that they frequent off shore waters. At no point in Alaska is it legal to extend a trap more than one-third across any body of water. It is but rarely ever necessary to consider this feature in southeast Alaska, as most of the channels where traps are located are several miles wide, and traps are but rarely of greater length in this region than 1,000 or 1,500 feet. On account of the rugged shores and deep waters it is impossible to build them of greater length. Nevertheless, a limit should be placed on the length of traps, as is customary elsewhere—notably the traps of Puget Sound.

A great deal has been said at times as to the waste caused by traps, but the facts do not bear out the contention that they are wasteful of food fishes. They may take a negligible number of fishes not at present utilized, such as sculpins, flounders, and trout. If such fishes as sharks, dogfish, sculpins, and trout can be captured and destroyed, there is a direct benefit to the salmon industry. Trout and sculpins are very destructive to young salmon.

From one point of view the purse seine is more wasteful than the trap. Seine boats are sometimes gone from the canneries for several days and the fish grow stale in the hold of the boat, particularly if the fishing is poor—which means visits to a number of small streams before a catch can be obtained that justifies a return to the cannery, or justifies a call of a run boat or collecting boat. The fish from traps are necessarily superior in quality to at least some of the seine fish, for with but very rare exceptions they are alive in the pot and spiller until a comparatively short time before being canned or otherwise used.

Against the charges of the purse seiners that the traps are monopolistic, it is to be noted that there were twenty independent traps in southeast Alaska in 1912, owned by individuals or groups of individuals wholly or nearly all residents of Alaska. One phase of the independent trap situation is that an individual stands an equal chance with the largest company in developing a new site, as favorable locations are not known until tried. Thus, if the independent owner by good fortune gets the better location, the preponderance of capital in the hands of the large company can hardly eject him.

On the other hand, in the case of the individual who can not command sufficient capital to build a trap, the seine or other less expensive apparatus is perforce his choice, and he then wants to abolish all traps, as they are in direct competition with him. But, as in other industries, competition when conducted legitimately invariably inures to the public good.

In the matter of preventing too heavy a drain upon the supply of salmon, a point in favor of the purse seine is that it can not operate in many places during stormy weather, and the fish have an opportunity to escape, whereas, unless conditions are unusually bad, a trap is likely to catch considerable numbers of fish when a purse seine can not be operated profitably.

On the other hand, however, it is the well-known habit of salmon to school outside the mouths of streams before ascending for spawning purposes. They are fish that have passed the traps. It is here that the purse seine is used most assiduously. Conditions were particularly bad in this regard during the summer of 1911, when some of the streams were so low that the fish were much hindered and sometimes absolutely prevented from ascending. Of course, this afforded great opportunity for the purse seine.

Originally the canneries depended chiefly upon seines to supply their fish. It is within the last few years that traps have come so largely into use, their vogue being due primarily to strengthened faith in their economy as a fishing appliance. Moreover, the fishermen's strike in 1912 revealed to the cannerymen the disadvantage of depending upon the fishermen with movable gear, and the higher wages demanded led to the adoption of traps in still greater numbers. A case in point is a large company which has operated four canneries in southeast Alaska for a number of years past, and used seine-caught fish exclusively until this season, when it began to install traps. All of this means that eventually a limit must be placed upon traps as well as other forms of gear, chiefly purse seines. To this end a Federal license system will be most helpful.

Regulation, in fact—the susceptibility of the fishing device to regulation is perhaps the prime factor in the whole question. As already stated, any form of gear unrestricted could deplete the re-

sources; therefore every form that is allowed must be regulated. If a particular kind of gear is not susceptible of regulation, or is less susceptible than some other, that other is to that extent more desirable in the interests of the fish supply. It is upon these considerations that the Federal Government bases its chief argument in behalf of traps. The trap has a definite location; consequently it can be inspected at any time, as the officers know where to find it. The purse seine moves constantly from place to place; therefore it is quite impossible for the Government, with present facilities, to regulate this form of apparatus—a regulation most essential because of the admitted tendency to operate purse seines in prohibited waters, notably entirely across stream mouths, and, of course, without detection. A purse seine can go into the mouth of a stream and get away unnoticed with a good catch of fish. An inspection force greatly disproportionate to reasonable requirements in such matters would be needed to look after seines.

Traps are in operation to-day on the Atlantic coast in the shad fishery, on the Great Lakes in whitefish operations, and in the Pacific States in salmon work. In regions where they are regulated, and are opened at certain times to let fish pass, the fishery is in no danger of extermination. In view of this fact and the history of the commercial fisheries everywhere, it must be conceded that the apparently irreconcilable differences in the purse-seine and fish-trap controversy in Alaska emphasize the necessity for unbiased legislation and regulation of Alaska fisheries such as the Federal Government, with its broader vision, can alone supply.

FEDERAL REGULATIONS.

Streams Closed to Commercial Fishing.

The canning interests in general agree that the closing of streams tributary to Cook Inlet, also Eyak Lake and stream, Anan Creek, and Naha stream, by order of the Secretary of Commerce of November 18, 1912, has been an excellent move in the preservation of Alaska's fishery resources.

As enumerated in the 1912 Alaska fisheries report, there are now closed to commercial fishing, by authority of the Secretary of Commerce, or by Executive order of the President, the following waters:

Western Alaska: Wood and Nushagak Rivers.

Central Alaska: All streams flowing into Cook Inlet; all streams on Afognak Island; Eyak Lake, including a limitation on fishing in Eyak River.

Southeast Alaska: Anan Creek, Naha Stream, Yes Bay and Stream.

The time is near at hand when it will undoubtedly be in the interests of the salmon fisheries of Alaska to close other streams to commercial

fishing, or at least limit either the season or form of gear, or both. The judicious application of Federal authority along these lines is in close keeping with the true principles of conservation.

PATROL IN SOUTHEAST ALASKA.

During the months of July and August, while salmon fishing in southeast Alaska was heaviest, a patrol was maintained to enforce the fisheries laws and regulations. This was conducted on a more extensive scale than heretofore. The Juneau region was covered chiefly by the newly purchased fisheries steamer *Osprey*, while the chartered power boats *Truth* and *Standard* operated in the Ketchikan and Wrangell regions, respectively. In addition the launch *Lue* was chartered for several trips in the Juneau and Icy Strait section, while a patrol of waters near the Yes Bay hatchery was maintained by a small launch attached to the station. During the 50 days or so of active patrol work, the first three named boats logged approximately 9,000 nautical miles. To this must be added the 800 miles covered by the two smaller boats. The total sum chargeable to this phase of the work, including charter of boats, salaries of regular employees, and all expenses, is approximately $5,000.

All told, five agents and deputies were engaged throughout the heaviest part of the fishing season, primarily to prevent infractions of the law, and at the same time to take the necessary steps to apprehend any offenders. Incidental work included the charting of traps and various fishery establishments, the distribution of laws and the posting of notices in regard thereto, the observance of salmon runs in various streams, and the enforcement of the fur laws. Visits to fishing grounds were regarded as more important than visits to canneries. The several patrol boats were on the move each day, unless detained by heavy weather or for other good cause, daily runs varying usually from 50 to 150 miles for each of the larger boats.

Particular attention was paid to the observance of the weekly close season, from 6 o'clock Saturday evening until 6 o'clock Monday morning, both as regards the proper closing of traps and the cessation of fishing by seines and gill nets. There has also been a constant tendency of seiners and others to haul their nets entirely across the mouths of streams, a practice contrary to law.

In the testimony of the commercial fishermen who appeared in Juneau last spring before the joint fisheries committee of the legislature, nearly every one freely admitted that there was frequent violation of the law, particularly in the matter of operating nets entirely across stream mouths, and often fish were driven downstream from spawning beds into the nets waiting below. They said this was due largely to the fact that with but one fisheries agent looking after all

of southeast Alaska, such a practice could be carried on with little or no fear of detection.

While, as a result in part of the agitation at Juneau during the session of the legislature, a much more effective patrol system was inaugurated this season in southeast Alaska, there is need of considerable more expansion along this line. More men and boats are needed. As a beginning, the steamer *Osprey* was put in commission this season, and three additional agents were detailed into this section of Alaska, where, by reason of the extent and character of operations, there is greatest need of regulation of fishing if the potential value of the waters is to be preserved. But rather than to be dependent upon the unsatisfactory method of chartering boats to further the needs of the patrol system, the Bureau should have in service at least three fast power boats of 65 feet or upwards in length and of staunch and seaworthy construction to withstand the sudden and violent gales of southeast Alaska, and to navigate, where necessary, outside waters.

Inspection of Canneries.

During the last year or so there has developed a feeling among various cannery men that a Government inspector should be stationed at each cannery to pass upon the condition of fish packed, also to see that sanitary features are fully observed, in manner similar to the Federal inspection of meat-packing houses and product. The theory of extending such inspection to Alaska is sound, but no funds are available for the employment of the force of 50 or more competent inspectors required to put the plan into effect. The managers of two companies, realizing the practical benefits of announcing the sale of goods packed under Federal supervision, have stated their willingness to pay the salary and expenses of an authorized and impartial Government inspector stationed at each of their plants. There are practical difficulties in the way of accepting pecuniary aid from private enterprise, however, therefore provision by Congress of a personnel and funds is the proper way to effectuate the plan.

Fishways.

There are several streams in southeast Alaska well adapted as natural breeding grounds for salmon, but impassable to the fish by reason of falls at or near salt water. It is hoped that steps can soon be taken to open up these waters either by blasting out resting places for the fish, or, better still, by installing suitable fishways. Of course, it is realized that it is difficult to do much, or even anything, in the case of various high and precipitous falls, but there are several streams where comparatively little work would make them available to spawning salmon. In the case of two or three streams not far from Wrangell, it would seem that a few well-placed charges of

powder would meet all requirements. Work of this character should be done during the winter, when the water is low.

As an example of the streams under discussion, there may be cited Mill Creek, which is 7 miles from Wrangell. At the mouth of this stream there is one almost sheer drop of 6 or 8 feet, even at higher stages of the tide, and above this is a series of cascades with a fall of probably 25 feet in a distance of about 75 yards. Were a fishway installed at the first drop, and a few resting places blasted out in the series of cascades, salmon could get into the stream above, which is about a mile long, and then pass into a fine lake 2½ miles in length. Each season considerable numbers of salmon collect off the mouth of the stream, but their attempts to pass the falls are without exception unsuccessful. It is particularly desirable to open up a stream like Mill Creek, which heads in a lake and therefore will be ascended by red salmon. When funds are made available, effective work can be done in accomplishing this end.

Lights on Fish Traps.

Under date of August 8, 1913, the Bureau of Lighthouses issued circular letter No. 329 to lighthouse inspectors, stating that the Secretary of Commerce had approved the following regulation, which will be included in permits that may be granted by the War Department for the erection of fishing structures and appliances in navigable waters of the United States:

Fishing structures and appliances in navigable waters of the United States shall be lighted for the safety of navigation, as follows:

The lights shall be displayed between sunset and sunrise. They shall be placed at each end of the structure, excepting where the inner end terminates in such situation that there is no practicable navigation between it and the high-water line of the adjacent coast, in which case no inner light shall be displayed. The outer light shall be white and the inner light shall be red. The size, capacity, and manner of maintenance of the lights shall be such as may be specified in the War Department permit authorizing the erection of the structure or appliance.

When several structures or appliances are placed on one line, with no navigable passage between them, they will be considered, for lighting purposes, as one structure.

Trap-Site Surveys.

In anticipation of early revision by Congress of the present Alaska fisheries laws, there has been considerable activity this season in the matter of surveying trap sites. Several of the larger companies as well as a number of individual trap owners have been to considerable expense in having surveys made. Since there has been no definitely established standard for surveying or determining the exact size and position of fish-trap sites, these efforts would seem to be somewhat premature. However, in the event of much needed trap legislation by Congress, possibly at least a part of the work already done may be made to apply to future requirements.

VIOLATIONS OF LAW AND REGULATIONS.

As in past seasons every effort has been made by the Bureau's agents and deputies to insure full observance of the fisheries laws and regulations. In this connection acknowledgment is made of valuable assistance and counsel through the cooperation of the United States attorneys and marshals.

The case of M. Kono and 20 other Japanese fishermen arrested during November, 1911, for herring fishing on Sunday was tried May 6, 1913, in the district court at Ketchikan. Judge Lyons decided that violation of the fisheries law as charged in the indictment was a misdemeanor, hence defendants might appear by counsel for arraignment and trial. The jury brought in a verdict of guilty and on May 8 two days later the court imposed a fine of $50 upon each of the 21 defendants. This fine is in addition to the cash bail of $1,000, which was forefeited upon failure of defendants to appear for rendition of judgment. In his instructions to the jury in this case Judge Lyons quoted section 5 of the fisheries law, which provides for a close season on salmon in certain waters of Alaska from 6 o'clock Saturday evening to 6 o'clock of the following Monday morning, and then quoted section 11, which subjects all species of fish to the provisions of the act. Judge Lyons stated that the provisions of section 5 are made applicable to all fishing within the waters of Alaska, including fishing for herring.

On December 22, 1913, in the United States commissioner's court at Craig a fine of $200 was placed upon Nels Husvig for wanton waste of herring contrary to the provisions of law. Complaint was made by Deputy Warden Walker, and a plea of guilty was entered. Large quantities of the smaller-sized herring had been thrown overboard.

The trial of W. E. Ludy, watchman, charged with failure to close Alaska Packers Association trap No. 9 on Sunday, July 28, 1912, occurred in the district court at Ketchikan May 7 and 8, 1913. The true bill rendered by the grand jury in October, 1912, included both W. E. Ludy, watchman, and the Alaska Packers Association, owner. Upon request of defendants separate trials were granted and the case against Ludy was called first. After two days devoted to the submission of testimony and arguments by counsel the case went to the jury and a verdict of not guilty was returned. In view of this verdict, the following day United States Attorney Rustgard moved a dismissal of the case against the Alaska Packers Association.

While on a trip up the west coast of Prince of Wales Island Sunday, August 24, 1913, Agent Smith and Deputy Lyman discovered driven trap No. 14, operated by the Craig cannery of the Lindenberger Packing Co., to be fishing illegally. The case was tried before the United States commissioner at Ketchikan August 27, and upon pleas of guilty being entered the company was fined $100, and Erick Peterson, trap watchman, was fined $10.

The case against the Alaska Pacific Fisheries and A. Carlson, owner and watchman, respectively, of a floating trap said to have been fishing illegally on Sunday, August 4, 1912, near the entrance to Yes Bay, as charged in a true bill returned by the grand jury at Ketchikan at the succeeding fall term, has not come to trial. A continuance was granted both at the spring and fall terms of court at Ketchikan this year.

While on patrol duty Sunday, July 27, 1913, in Cholmondeley Sound, Deputy Lyman discovered that the walls of the heart of floating trap No. 4 belonging to the Alaska Pacific Fisheries were in fishing position contrary to law. The watchman claimed that no instructions had been given him as to the method of closing the trap against fishing. An information was accordingly filed with the United States commissioner at Ketchikan, naming the Alaska Pacific Fisheries, owner, and Chris Adams, watchman, as defendants. Upon citation, the defendants appeared in the commissioner's court on July 30 to answer to the information. The testimony that the heart walls were in fishing position was not controverted, but the court decided that since counsel for the defense had introduced testimony that holes existed in the trap, amounting to 30 square feet or more, a passage for the fish existed, and the defendants were accordingly discharged. This decision has occasioned some surprise, for the law says nothing about holes, but states that the heart walls must be lifted or lowered for a distance of 25 feet on each side next the pot so as to permit the full and unobstructed passage of salmon and other fishes.

Early in the fishing season one of the deputies discovered a gill net stretched entirely across the mouth of the red salmon stream at the head of Nakat Inlet. Every effort was made to apprehend the guilty parties, learned to be Indians, but their identity was not ascertained. Violations of the law of this character are most vicious and harmful, for there is no more certain way of destroying the fishing industry than by preventing at least a reasonable escapement up the streams for spawning purposes.

A report was received from the deputy collector of customs at Cordova that fishing apparatus had been set, by persons unknown, in Eyak Lake, contrary to the closing order promulgated by the Secretary of Commerce on November 18, 1912. An order of seizure was issued and a special deputy marshal was named to take the gear, but by the time that officer arrived it had been removed. No further action occurred.

There has been some dissension and complaint among the fishing interests of southeast Alaska, and particularly at Hetta Inlet, as to the time when seining operations shall cease in accordance with the provisions of the weekly close period. Six o'clock in the evening is the hour prescribed by law, but as there has been considerable

variation in the time kept at different canneries, one crew would sometimes fish an hour or so longer than another. To avoid infractions of the law or further trouble, directions were given to have the crews fishing at Hetta make their time uniform. Where variations in time are more than nominal, the companies fishing later than the standard time of a given region will be subject to prosecution.

Various rumors and vague reports were received from time to time as to alleged illegal fishing, but no direct evidence would be forthcoming or could be obtained. It is usually the case that those who note infractions of the law feel that they can not jeopardize their business relations by reporting the matter in a way that will permit of an action at law. If a more vigorous and healthy public sentiment can be developed along this line, the way of the transgressor will be made much more difficult.

Because of the unattractive price on chums, a number of cannery men were not very scrupulous as regards the section of law prohibiting the wanton waste of salmon or other food fishes. Several cases were investigated, and one was brought to the attention of a grand jury, but the evidence did not warrant further action.

It has been construed recently that violations of the fisheries laws and regulations fall within the misdemeanor class, hence an alleged violator may, in the discretion of the prosecuting officer, either be tried before a United States commissioner, sitting as a justice of the peace, ex officio, or said United States commissioner may sit as a committing magistrate merely to give a preliminary hearing to determine whether the evidence justifies binding the defendant over to the grand jury.

Pursuant to an opinion by United States Attorney Rustgard it was determined this season that in the event of violation of the fisheries laws or regulations complaint would be made against the company or corporation involved, as well as against the individual fishermen, watchmen, or other person or persons immediately concerned in the violation.

If it is found that difficulty exists in obtaining convictions in fisheries violations, there is good ground to ask Congress that greater powers be vested in the fisheries agents and deputies. This might consist of more extended authority in the matter of confiscation and destruction of gear operated illegally. This is along the line of similar powers conferred upon collectors of customs and other Government officers.

The practice in the Bering Sea region of putting pink salmon labels on the pack of chum salmon is contrary to the provisions of law, and hereafter must be discontinued. The chum salmon of Bering Sea is no better than the chum of southeast Alaska, and there appears to be no justification for the use of a pink salmon label in western Alaska on the chum pack.

So far as the interior of Alaska is concerned no serious violations of the fisheries laws have been reported. Two nets were removed from a small stream near Hot Springs and one from Clear Creek near Fairbanks. It was reported that a trap entirely blocked the Chatanika, but the trap was removed before the arrival of the warden and evidence could not be obtained of the guilty parties. It was reported that at Chicken Creek near Eagle prospectors blocked the stream with traps in the fall until they obtained sufficient whitefish to freeze for their individual use during the winter. It was reported at Fairbanks that fish were being used for fertilizer, but upon investigation it was found that the report was based upon the use of a single load of offal from fish being dried.

OBSERVATIONS IN THE WOOD RIVER AND NUSHAGAK REGIONS.

During the fishing season of 1913 the Bureau was represented in the Nushagak Bay region by Deputy Fur Wardens Hanna and Roach, on special detail for the purpose. Having arrived at Nushagak overland from Bethel early in the spring they began active operations in relation to the fisheries on June 5. On that date they went to Lake Aleknagik and began overhauling the gear to be used in connection with the investigation of the run of salmon in Wood River.

The construction of the rack, begun on June 14, was completed on June 21, and the actual counting of the fish was begun the next day. The census was taken in the same manner as in the preceding five years, and covered the period from June 22 to July 28, both inclusive. The maximum daily count was 121,981 red salmon. This occurred on July 5, while the next largest count was 100,383 on July 1. The run on the day following each of these dates was very much reduced, in view of which fact it would seem that the season's run reached its maximum on July 3 and 4, when 91,203 and 91,186 fish were counted, respectively. The maximum run in 1911 occurred on July 15, and in 1912 on July 8.

The following statement shows the tally of red salmon at the Wood River (Lake Aleknagik) rack in 1913:

	No.		No.		No.
June 22	246	July 5	121,981	July 18	529
23	4,180	6	11,977	19	297
24	2,991	7	33,698	20	690
25	2,560	8	31,323	21	306
26	1,737	9	35,991	22	1,658
27	7,489	10	27,907	23	538
28	12,528	11	20,038	24	304
29	16,022	12	18,917	25	1,841
30	47,134	13	14,296	26	463
July 1	100,383	14	4,651	27	1,212
2	36,192	15	3,228	28	1,022
3	91,203	16	2,788		
4	91,186	17	3,603	Total	753,109

The relation of the catch of salmon in the Nushagak region to the escapement into Wood River is shown in the following table:

RED SALMON RUN IN NUSHAGAK BAY AND TRIBUTARIES, 1908–1913.

Year.	Nushagak Bay catch.	Wood River tally.	Total.	Per cent of escape.
1908	6,140,031	2,600,655	8,740,686	30
1909	4,687,635	893,244	5,580,879	16
1910	4,384,755	670,104	5,054,859	13.2
1911	2,813,637	354,299	3,167,936	11.1
1912	3,866,950	325,264	4,192,214	7.7
1913	5,236,008	753,109	5,989,117	12.5

From the foregoing it will be observed that the escape in 1912 was 7.7 per cent, while in 1913 it was 12.5 per cent. The total Nushagak run of red salmon, including both the catch and the count at the rack, increased from 4,192,214 in 1912 to 5,989,117 in 1913, a gain of 30 per cent.

Attention has already been called to the fact that in considering these figures it must be remembered that an unascertained number of red salmon ascend to spawning beds in the Nushagak River. This number, however, is small compared with the number ascending Wood River. While the count of those entering Lake Aleknagik does not therefore show the escape for the entire bay, it does nevertheless show the relative escape year by year. It may be assumed that the run into Nushagak River is an approximately constant factor as to the percentage of the entire run, and does not vitiate the deductions that may be drawn from a study of the Wood River counts and the Nushagak Bay catches.

During the season officers of the Northwestern Fisheries Co. and of the Alaska Fishermen's Packing Co. (Libby, McNeill & Libby) made a trip to Lake Aleknagik to inspect the spawning beds and to make a personal investigation of rumors current for several seasons that the Government rack is a detriment to the salmon industry because, it is alleged, fish do not lead through it. The absurdity of these reports was readily established, as all operations were found to be conducted properly and there was no evidence that the salmon did not pass through the rack. During the course of the season 124 dead salmon were found about the mouth of Lake Aleknagik, all of which had died from gill-net injuries received before they entered Wood River. The presence of the Government rack for counting operations had nothing to do with the death of these fish. The derogatory rumors respecting the rack have been spread by persons utterly uninformed as to the real situation.

Observation was made at the rack again this year of the proportion of salmon showing injuries from gill nets operated on Nushagak Bay. It was determined that the number thus injured and escap-

ing comprised 17 per cent of the total number of red salmon entering Lake Aleknagik.

Operations at the rack were facilitated very largely through assistance rendered by the Alaska Packers Association. The Alaska Portland Packers Association furnished a boat for towing equipment to the rack site.

The Department's order of December 17, 1907, closing Wood and Nushagak Rivers to commercial fishing, was disregarded this season by some natives who operated stake nets in the restricted region and sold the catch to neighboring canneries. It is the purpose hereafter to allow the use of native stake nets in the closed waters for domestic purposes only. During the past season most of the 236 stake nets in operation were outside of the closed region.

A patrol was again maintained this season to see that fishing boats from the canneries did not invade the restricted waters. To insure a uniform determination season by season of the mouths of Wood and Nushagak Rivers, fixed range markers have been established. These markers are of iron pipe set 40 feet apart, the first being 12 feet back from the edge of the tundra bank. The bearing of the Wood River ranges above Snag Point is NE., while those for the Nushagak River are at Picnic Point and bear N. From these ranges piles are fixed offshore for the guidance of the fishermen.

AFOGNAK RESERVATION.

FISHING REGULATIONS.

On March 21, 1912, the following order was issued by the Secretary permitting a limited amount of commercial fishing in the reserved waters of the Afognak Island Reservation:

To whom it may concern:

A proclamation by the President of the United States, promulgated December 24, 1892, created the Afognak Forest and Fish Culture Reserve, which is now a part of the Chugach National Forest. The proclamation states that—

"There is hereby reserved from occupation and sale, and set apart as a Public Reservation, including use for fish culture stations, said Afognak Island, Alaska and its adjacent bays and rocks and territorial waters, including among others the Sea Lion Rocks, and Sea Otter Island: *Provided*, That this proclamation shall not be so construed as to deprive any bona fide inhabitant of said Island of any valid right he may possess under the Treaty for the cession of the Russian possessions in North America to the United States, concluded at Washington, on the thirtieth day of March, eighteen hundred and sixty-seven.

"Warning is hereby expressly given to all persons not to enter upon, or to occupy, the tract or tracts of land or waters reserved by this proclamation, or to fish in, or use any of the waters herein described or mentioned."

Sections 3 and 7 of "An act to establish the Department of Commerce and Labor," approved February 14, 1903, transfer the supervision and control of the salmon fisheries of Alaska to the Department of Commerce and Labor.

In the exercise of the authority derived from these sources the following regulations governing the reserved waters herein defined are hereby established and promulgated:

1. No person or persons other than the natives of Afognak Island now resident thereon will be permitted to fish in the reserved waters.

2. Licenses for fishing will be granted to the said natives upon application to the Secretary of Commerce and Labor or such representative of the Department of Commerce and Labor as may from time to time be designated by the Secretary.

3. The kinds and amounts of apparatus to be used, the places where and the manner in which it may be operated, and the time when it may be employed will be determined by the Secretary of Commerce and Labor and will be subject to changes or modifications from time to time at his discretion.

The foregoing regulations were supplemented by order of February 6, 1913, extending privileges to residents of certain near-by islands; also placing white men married to native women on the same basis with regard to fishing rights as the natives. The supplemental order is as follows:

To whom it may concern:

Department circular No. 238, issued March 21, 1912, for the regulation of fishing in the waters of Afognak Reservation, Alaska, is hereby amended so as to grant to natives of Spruce, Whale, Dry, and Raspberry Islands, Alaska, the same fishing privileges in Afognak waters now accorded natives of Afognak Island. White men married to native women will be granted the same privileges as the natives.

Early in the year the question arose as to the fishing privileges to be accorded those persons entitled to fish in the reserve who moved away from Afognak during the previous winter and who expected to return temporarily with the opening of the spring fishing season. The decision was reached that if the absence should be of a sufficiently permanent character whereby they could no longer be termed residents of Afognak they should be denied licenses if they returned temporarily for that purpose. In other words, their ordinary birthright privilege of fishing would be surrendered if they acquired a residence elsewhere. If, however, a native should seek employment elsewhere for a time, but in reality still called Afognak his home and he should be recognized commonly as an Afognak native in contradistinction, for instance, to a Kodiak native, he would as a matter of equity be entitled to fish in Afognak waters. If a native should surrender his fishing privilege by acquiring a residence elsewhere the surrender need not necessarily be permanent, for, under proper bona fide intentions, it might be possible to reacquire a residence on Afognak and attendant fishing privileges. But to preclude the possibility of fraud the right under this proviso must be clearly established.

Immediate supervision of fishing operations was placed in the hands of E. M. Ball, inspector, Alaska salmon fisheries, on duty in this region, and the report herewith is derived largely from his notes. Additional regulations to meet local conditions for the season were issued by Mr. Ball on May 24, 1913, covering the following points:

1. Fishing in Letnik Bay, for commercial purposes, is prohibited throughout the season. Only the general fishery law shall apply in all other localities within the reservation.

2. Fishing gear is restricted to the use of haul or drag seines not exceeding 200 fathoms in length.

3. Orderly conduct of operation is required at all times.

4. Licenses to fish in the reserved waters of Afognak will be revoked for any violation of this order.

The Malena fishery, where last year a midweek close period of 36 hours was enforced, is so located that winds from the west and southwest interrupt fishing, and in this way several days' protection is afforded, thus making unnecessary any further special regulation on the subject.

It has been suggested that the Sunday closing provided by statute is of doubtful benefit to the small streams of this locality, as the protective period is too short to give the salmon more than an opportunity to approach the streams. The movement of these fish into fresh water is deliberate, and before the demands of nature have become sufficiently urgent to induce them to leave the sea they may be taken by the fishing gear on Monday. The catch on Monday is usually better than on any other day of the week. On account of this habit of the salmon to school off stream mouths, the efficacy of the close period in allowing an escapement of breeding salmon upstream is much lessened when fishing gear such as purse seines and beach seines are allowed too close to stream mouths. The theory has been advanced that this condition may be bettered by establishing a continuous close season for a period of from 5 to 10 days while the run of salmon is good. Such action, however, would likely meet with considerable opposition at the hands of the fishing interests.

Catch of Salmon.

During the fishing season of 1913 licenses were issued to 71 persons to fish in the waters of Afognak Reservation. Though the fishermen departed to the several fields in May, it was not until late in June that the number of salmon coming to the streams was enough to warrant continuous operations. Eleven crews, of from four to seven men each, operated at the several fisheries of the island. They moved from one field to another as they felt disposed, being actuated in this regard entirely by the reported runs of salmon.

The first sockeyes appeared early in May, as is usual in this region, but their movement into the streams was checked by the large quantity of volcanic ash from the Katmai eruption of 1912, that was being washed from the hills by melting snow and heavy rains of the month. Letnik Bay and stream, which receives the hatchery run, fared worse in this regard than any of the other localities, and at one time it was

feared that no fish might appear. On July 7, when the rack across the stream was removed, only 48 red salmon had entered the lake. Ordinarily this date would have marked the end of the running season. The number of salmon attracted to Letnik Bay was markedly less than in 1912, when the decline was approximately 50 per cent. Figures for this year taken from the hatchery records show that 3,367 sockeyes and 6,882 humpbacks reached the spawning grounds covered by hatchery operations.

The production of the Afognak commercial fisheries for 1913 is shown, by locality and species, in the following table, which does not include the hatchery fish in Letnik stream:

CATCH OF SALMON IN THE AFOGNAK RESERVATION, SEASON OF 1913.

Locality.	Sockeyes.	Humpbacks.	Cohos.	Total.
Malena	41,536	8,472	.....	50,008
Paramanoff	26,958	288	.....	27,246
Seal Bay	20,173	859	.....	21,032
Little Afognak	8,682	1,443	4,113	14,238
Izhut Bay	3,188	15,793	.....	18,981
Danger Bay	451	20,818	.....	21,269
Total	100,988	47,673	4,113	152,774

Compared with 1912, the foregoing shows a gain of about 18,000 sockeyes; humpbacks are practically the same, while cohos have fallen off about 4,000. Most of the places fished show a larger catch of sockeyes than in 1912. Seal Bay leads with an increase of 7,744; Paramanoff comes second with 6,693; Little Afognak third with 1,665; while Izhut and Danger Bays, where no sockeyes were taken last year, produced 3,188 and 451, respectively. Malena shows a falling off of 1,154, but this decline may be only apparent, as the figures for last year included, as far as possible, all salmon consumed fresh by the fishermen or salted by them for winter use, whereas for this year no similar figures were obtained.

The only localities fished for humpbacks were Danger and Izhut Bays, and only at these places because of their relative proximity to the Kodiak cannery. The superabundance of humpbacks throughout the region during the season made it unnecessary and unprofitable for the cannery boats to go to the more distant places for this species. Though some humpbacks were taken at all the island fisheries, the catch except at the two fields just named was merely incidental to the operations for sockeyes. Positive evidence that the run was good in all localities is lacking, but it is probable that there was no great disparity in the number of humpbacks coming to the several streams.

This condition may also be true in regard to the number of cohos selecting these waters for spawning purposes. Fishing was carried on only at Little Afognak, and the catch was limited by reason of

the fact that the Kodiak cannery had about made a capacity pack before the appearance of the cohos. Other localities, doubtless, would have shown a run equal to that of last year. Dog salmon were very scarce, only a few being taken during the season.

The total value to the fishermen of the salmon taken from Afognak waters was $4,155, or $243 less than the amount reported as the value of last year's catch. The fishermen were paid at the rate of $35 per thousand for sockeyes and cohos and at the rate of $10 per thousand for humpbacks. All salmon taken commercially from Afognak waters were sold to the Kodiak Fisheries Co. at Kodiak.

Eruption of Katmai Volcano.

In view of the important and more or less disastrous effect which the eruption of Katmai Volcano in June, 1912, had upon the fisheries, fur animals, and other animal and plant life of the Afognak Island Reservation, E. M. Ball, inspector, Alaska salmon fisheries, then at Afognak, was instructed to make a special investigation of the subject. He did so, and his report, which covers well many phases of the matter, is here presented.

The data which are presented in this report were obtained from two sources; direct examinations, and conversations with fishermen, boatmen, and miners. The results of personal investigations treat almost exclusively of conditions on Afognak Island; while the information received from individuals refers to localities beyond the reach of the writer. Where a number of opinions are concerned, each differing widely in essential features, it is not always easy to ascertain the facts. First reports are often unduly colored by the stress of the moment, and, therefore, in the light of subsequent events, are subject to modification. Enough is known, however, now three months after the eruption in question, to warrant the preparation of a brief report thereon, and its effect upon the animal and vegetable life of Afognak Island.

Description of volcano.—The Alaska Peninsula forms an important link in the chain of volcanoes which extend the entire length of the Pacific coast of the American Continents; and, as a region of volcanic activities, it is, perhaps, second only to the great centers of the Torrid Zone. These activities are made known by the smoking volcanoes of Redoubt and Iliamna on the shore of Cook Inlet, Pavlof on the western end of the peninsula, and Shishaldin on Unimak Island. Many others less notable occupy the intermediate territory, some of which are of comparatively recent discovery.

To this class belongs Katmai Volcano, a peak 7,500 feet high. It is located near latitude 58° 16′ and longitude 155°, or about 20 miles north of Katmai Bay and 60 miles west of Afognak. Information as to its general appearance is not obtainable, but prospectors and hunters who in other years had traveled through that section of the country tell us that the volcano is not marked by any great prominence and is not readily distinguishable from several peaks in its vicinity of approximately the same elevation. Neither they nor those who have always lived in this region have any knowledge either direct or traditional of its former activities. As far as the Kodiak group of islands is concerned, many believe that indications of a previous eruption can be found several inches below the surface of the ground in a layer of soil which in color and composition resembles the ashes now covering the islands; but the acceptance of such evidence as a scientific fact is questionable.

The eruption.—In the history of volcanoes elsewhere, it has been recorded that approaching eruptions were preceded by rumbling noises and trembling movements of the earth. In this instance, however, no warning was given to the people of Afognak

that a volcanic outburst had occurred until mid afternoon, June 6, 1912, when a dark cloud was observed rising from the west. It is not improbable that there were light convulsions of the earth, which, because of their frequency in this region, passed unnoticed.

The day on which the eruption began was one of more than ordinary pleasantness. The warmth and brightness of the sun, coupled with a gentle breeze from the west, made it an ideal summer day. Air temperatures at morning, noon, and night were 52°, 58°, and 52° F., respectively; and water temperatures for the same hours were 41°, 42°, and 49° F.

Many interesting phenomena, particularly the rise, spread, and rapidity of the eastward movement of the ash clouds, might have been observed at the beginning of the eruption if the village of Afognak had been situated on the west coast of the island where the mountains of the mainland are clearly visible on bright days. Located as it is on the lowlands of the eastern shore, the view to the west is shut off by forest and mountains. For this reason the cloud attracted no attention until its crest rose high above the hills, when its blackness and otherwise peculiar aspect became the subject of some comment. The first impression received by those who had lived in other parts of the land was that a thunder storm, characteristic of more tropical regions, was approaching; but being unaccompanied by lightning and apparently no wind, the cloud was next supposed to be due to a probable fire on the peninsula. By this time the silence was ominous, and even the birds seemed to feel impending disaster, yet no special apprehension was noted among the people of the island.

The shower of ashes began about 6 p. m. The hills were then enveloped in an amber-colored haze, the sky was overcast in all directions except a narrow border along the northeastern horizon, and the air seemed strangely warm. As the storm progressed, the shower increased in density until absolute darkness prevailed; even artificial light could be detected only a short distance. This sudden and early darkness became all the more alarming, because during June there is no night in this latitude, merely twilight from 10 p. m. till 2 a. m.

Probably an hour after the ashes began falling the first rumbling noises were heard, suggestive of the detonation of distant blasting or firing of heavy artillery. Soon thereafter lightning was observed, the flashes becoming more frequent as the night advanced. Some observers describe these flashes as being balls of fire which would burst with a loud report into a shower of sparks. Thunder seemed nearly incessant. The highly electrified condition of the atmosphere was shown on the set of wireless instruments at the Federal hatchery. Although the aerial switch was open, tiny blue flames could be seen on the switchboard and the tuning and induction coils. Whenever the lightning flash was near these flames would shoot out with a keen report like that of a rifle. Associated with these phenomena were the earthquakes, which varied in violence from gentle vibrations to shocks that made the buildings creak and tremble. The most violent convulsions were of several seconds' duration and were usually attended by rumblings.

Beginning about noon, Thursday, June 6, and ending Sunday morning, the 9th, this eruption may have been a continuous operation; but observations made at Afognak seem to show that the discharges were intermittent. This conclusion is based on the fact that there were three distinct showers of ashes, separated by short intervals of comparative quiet.

The first break in the storm came on the morning of the 7th and continued for a space of 10 hours. About 4 o'clock that afternoon the second shower began, bringing with it all the phenomena of the first, but with renewed energies. This was the period of greatest distress to man and beast; to man, mentally, in that the end of it all was uncertain, to the beasts and birds in that there was no escape from the blinding, suffocating dust which was carried into every nook and crevice. Alarm was felt lest the ashes be followed by poisonous gases from which there could be likewise no possible escape. But after 23 hours of uninterrupted fury the second storm had spent itself.

Daylight came at 3 p. m. on Saturday the 8th, only to be dispelled in 5 hours by the third storm which, however, was of short duration and without the violence of the preceding storms. Though the air was full of ashes many days, Sunday morning marked the end of the eruption as far as it had any effect upon the daily seasons. Throughout the storms the air was cool and remarkably free from fumes; temperatures, after the sudden decline at the beginning of the eruption, fluctuated but little; air held close to 44° F., water at 39°.

Region affected.—The region affected by this eruption lies almost entirely east of the volcano. Though traces of dust have been reported from Fairbanks, Alaska, and British Columbia and Puget Sound points, the eastern limit to which any appreciable quantity of ashes was carried should be fixed well out in the North Pacific Ocean. To the west ashes are not found more than about 25 miles from the volcano. The ash clouds moved eastward across Shelikof Strait to Afognak and Kodiak Islands, spreading north and south as they advanced until by the time the one hundred and fifty-second meridian was reached they covered a zone nearly 150 miles in width. The northern boundary of this zone can be represented by a line extended from Hallo Bay on the peninsula northeastward to Barren Islands and beyond; its southern limit is shown by extending a line from a point 25 miles west of Katmai Bay to Cape Karluk, thence crossing Kodiak Island to Shearwater Bay. Within the affected zone as applied to the islands, a belt 50 miles wide with Kupreanof Strait as its center embraces the area most heavily covered with ashes.

Quantity and character of material ejected.—Over the central region ash fell to a depth of 10 inches. It is found in three layers, representing the three showers. The first layer, measuring 3 inches in depth, consists of fine gray sand whose grains are of three kinds; some are nearly white and opaque, others are transparent resembling small particles of sal ammoniac, and the rest are black or dark amber and susceptible to magnetic influences. The second layer, 5 inches deep, is composed entirely of fine brown dust, which when falling so filled the air that it affected the eyes, nasal passages, and throat of everyone. The third and uppermost layer measured 2 inches in depth and it also is a flour-like dust of a light gray color.

North and south from this central region the ashes gradually diminish in depth until the border of the affected area is reached, each layer being proportionately reduced.

Besides the dust and sand ejected by Katmai Volcano a considerable quantity of pumice stone was thrown out. These stones ranged in size from small particles to those several inches in diameter, and they varied in color as did the ashes. All this coarser material fell on the mainland not many miles from the volcano. The streams and rivers of the vicinity carried it to the ocean where it formed into large fields that were moved here and there by winds and tides and piled 2 or 3 feet deep on the beaches of the islands.

Immediate effect of eruption.—The winter and spring had been favorable seasons; deciduous bushes were opening into full foliage; perennial plants had made a remarkable growth, particularly in the lowlands; the birds of summer were nesting and filling the land with song; salmon were entering the streams and lakes and were appearing in good numbers in the bays; even the mosquitoes and sand flies were making their presence known. The snow had gone except on the tops of the hills; the lakes had been free from ice since early in February; streams were very clear and at their normal flow.

But in the immediate effect of this eruption, these things were laid waste and made hideous and appalling by the mantle of ashes which fell over them. Trees were loaded to the breaking point and the plants were in great part buried. With the possible exception of some of the small rodents, mammals were not seriously affected, only as it may have been more difficult to find food. But many of the smaller birds perished, while the living members of their species had flown to other regions. Only the eagles, ravens, magpies, gulls, and ptarmigans remained to the end in the face of destruction to their nests and young. Half-grown ravens were found dead

where they had fallen from the nest, driven therefrom no doubt by hunger or fright; and it seems probable that in like manner death came to all other young birds unable to fly. As the slightest interference or molestation is often enough to cause birds to forsake their nests, there is every reason to presume that all nests, whether built on the ground or in the trees and bushes, were abandoned under the shower of sand. Of all the birds on the island, the ptarmigans probably suffered greatest loss, for they alone were incapable of flight to regions beyond the stricken zone; and as they live, feed, and nest exclusively on the ground, and inhabit the higher untimbered sections of the southern end of the island where the greatest quantity of ashes fell, their suffering must have been acute and little hope can be entertained that all survived. The food supply was cut off, nests and young destroyed, and an endless field of dry ashes lay about them. The condition of the birds, however, did not more than equal the plight of the fish in the streams.

Many of the streams were occupied by spawning steelheads, and those lake-fed were filled with ascending red salmon. These fish, as long as they had strength to stand against the current, could not be moved by the turbid waters from obedience to the commands of nature; but as the water became almost liquid mud their gills were loaded with sediment until suffocation resulted and they were finally washed to the bays with the sand and mud. Fortunately the run of salmon had just begun and therefore the loss of fish for the whole island was small. An approximate loss of 4,000 red salmon resulted in the Letnik stream, where the fish were being held for cultural purposes. At the other fisheries the loss was negligible, but few fish having entered the streams.

Ocean waters, except where affected by streams, were only slightly discolored for a few days, and it did not seem possible that in waters of considerable depth there could be any great upsetting of natural conditions. It appears, however, that the change was great enough to cause the cod to abandon their banks; where heretofore they could be had in abundance none can now be taken.

Another most striking and noteworthy effect of this eruption on marine creatures was the destruction of sea urchins, which in large numbers were cast upon the shores or drifted about the bays and straits. There was also a considerable loss of mollusks, particularly clams and cockles, which is hard to understand in view of the fact that their native element is mud.

In order to determine, if possible, what had been the effect of the ashes upon the food supply of the fishes in fresh water, an examination was made of all the principal water systems of the island. It was found on the eastern half, which is heavily wooded with spruce and less mountainous than the western side, that the lakes and streams had not been choked with ashes and little wash from the surrounding country had taken place. In these waters, especially the lake and streams of Little Afognak, the supply of mollusks and worms was adequate and some larval forms were collected. No crustaceans could be found.

The streams and lakes of the west side of the island are almost destitute of fish food. In this more mountainous section where the fall of ashes was heavy, the streams were literally choked with sand and mud; old channels were obliterated and the water spread in a thin sheet over the meadows. Those discharging into lakes formed large sand bars at their mouths, sometimes several feet in depth and of considerable area.

In the examination of lakes, all operations were conducted from the shore and with much difficulty, there being such an accumulation of ashes in the lakes that the net was often filled and wrecked by overloading. But when successfully landed, the search through the sand for living creatures was often fruitless, only a few mollusks appearing as the result of efforts made on Paramanoff Lake and its streams. This region forms one of the most barren fields, not alone of small organisms but fish life as well, that can be found on the island. By seining in the creeks with the plankton net two small trout were caught, one about 3 inches long, the other about 5. In the

stomach of the smaller fish were eight minute worms, some sand and vegetable matter; the stomach of the larger specimen contained one maggot and three salmon eggs.

As a water system destitute of fish food, the Malena Lakes and streams comprise an area which is almost the equal of Paramanoff. Not taking into account the salmon that had entered the lakes to spawn, the only fish found in the upper lake were sticklebacks. In the lower lake, sticklebacks and salmon fingerlings were observed, and a mixed collection of about 40 specimens was made in order to ascertain by examination of stomach contents what food these fish were finding. Only juices were found in the stomachs of the salmon, and that was also very generally the case with the sticklebacks, though one specimen had eaten a small mollusk, and two or three others had found a few small worms. All of the fish were in a much emaciated condition, which alone would seem sufficient evidence of the scarcity of food.

Better conditions were found in the Letnik Lake region where the small streams had generally cleaned themselves of ashes by the end of August. From the gravel bottoms of these streams many mollusks and worms were collected. The larger streams were still gorged with sand, therefore it seems probable that whatever fish food may have abounded in them had been completely destroyed, and this view was confirmed by the unsuccessful efforts to find living organisms within those areas. In the shoal places of the lake, mollusks, large and small, were present in fair abundance, so also were small bugs and worms, but in the deeper waters dredgings were without results. Specimens of young fish were collected in the small streams and lake. Those from streams were strong and well fed, but the lake fish were lean and weak.

These investigations, however, offer no convincing proof that any great destruction of fish food resulted as a consequence of the eruption, though they may show an impoverished condition of the waters. Unfortunately nothing is known of the scarcity or abundance of fish food in these lakes and streams before the volcanic eruption. Data of that kind would now be valuable for purposes of comparison, for only in that way could the destruction be determined. The almost total absence of mosquitoes and sand flies during the summer is attributed to the immediate effect of the ashes upon their larval forms and breeding places; and this condition, coupled with the fact that these insects had been veritable pests in past summers, establishes conclusively that the weaker forms of life were destroyed in large numbers.

Later effects.—For several days after the eruption, the fate of vegetation on the southern part of the island could not be told. It seemed certain that the greater part of it could never penetrate or push its way through 10 inches of compact ash; the danger was wholly one of being smothered, as the ash possessed no inherent properties that would be detrimental to plant life. In the course of a few days, some of the more robust plants were able to throw off the weight of ash and continue their growth; but there was no general renewal of plant life until near the end of June, when the rains came and caused the hitherto unbroken surface to crack in all directions and break into small sections like parched clay. Through the interstices thus formed, plants made a remarkable growth, so that by the end of summer the hills and valleys were covered with a rank vegetation which, viewed from a distance, seemed barely less luxuriant than in previous seasons. Close examination, however, revealed the fact that this vegetation was made up almost exclusively of stout-stemmed plants, the most conspicuous members of the group being the hellebore, water hemlock, broad-leaved dock, and the fire-weed, which outnumbers all the other species.

But of all the plants, probably none will be as seriously affected as the mosses, not alone on account of their greater abundance but rather because of their delicacy. One species bears a berry which s an important food of the ptarmigan in the fall and early winter.

Associated with the mosses are the "marowskas" and cranberries, both of which are of some importance in that they form a part of the food supply of the people of the island. They were so nearly wiped out by the ash that none could be gathered this year.

The grasses suffered extensively on the southern end of the island; probably three-fourths of the crop was destroyed. This is an economic loss to the owners of cattle, for they have been unable to harvest sufficient hay to carry their stock through the winter. An abundant supply could be had from the northern end of the island where the grass was only slightly affected; but the people lack the means of transportation and, therefore, as available provender, it need be given no consideration.

If the destruction of plant life were expressed in figures, it would be fair to estimate that 70 per cent of the flora on the southern end of the island had been destroyed and that there was a gradual falling away to a loss of 20 per cent on the northern end.

The most amazing effect of the volcanic ash upon aquatic plants is shown by the retarded growth of the kelp on the reefs and rocks of the stricken region. Opinions differ as to the degree of injury. Many believe that the kelp is dead, and, as confirmation of their judgment, they point to its black and withered condition. But admitting that appearances strongly favor this view, it seems, nevertheless, too early to give unqualified endorsement thereto. The destruction of the kelp would mean an inestimable loss to the cattle, as it forms one of their staple foods during the winter and very materially helps out an inadequate supply of hay.

In the mountainous sections, the rains kept the streams and lakes very muddy, thus preventing or delaying the appearance of the salmon on the spawning grounds. About the middle of August so much ash was washed into the streams that several hundred spawning salmon perished in exactly the same manner as happened at the beginning of the eruption. It is an interesting evidence of the objectionable condition of these waters that many of the salmon would ascend the streams a short distance, and then return to the sea, repeating many times these erratic movements.

Of the ground-nesting birds, the ptarmigans are the most important and, perhaps, the ones most unlikely to nest in the ashes. Their nests are always carefully concealed in the dry grass and weeds of the open country or under the scrub spruce where the branches are close to the ground. All such places being covered with ashes, it seems improbable that any nests were built after the eruption, and this doubt is strengthened by the fact that no young birds were seen during the summer. On the other hand, the gulls resumed their nesting before the end of June, the ashes presenting no special hindrance to them, as they require very little material for nests. The number of ducks and small migratory birds breeding on the island was considerably less than usual.

Mammals in general were able to weather the distressing conditions, though at times they may have found it difficult to obtain food. In a way, the land otters are the most fortunate of these animals, for they can go to salt water for food when the fish are scarce in the lakes and streams.

Probable future effects.—The conditions of to-day do not warrant the assumption that the Kodiak group of islands has been permanently injured by this eruption, though a few years may be required for nature in her varied forms to work out a complete readjustment of these changes. Surely, the soil will be enriched and vegetation will renew itself until the islands are more luxuriantly clothed than ever; the wash of ashes from the hills will cease and the streams will eventually clear themselves. What enriches the soil may also enrich the waters by contributing to conditions that will bring about an increased supply of fish food which in turn means an increased supply of fish.

Effects of Katmai Eruption Evident in 1913.

The question has been raised as to what effect the fine volcanic material from the 1912 eruption may have had upon the spawning grounds of the salmon in this region. It was found that in still lake waters not in proximity to the mouth of a stream this material settled and formed a very solid though thin layer of soil, but where it

was deposited by the streams—often to a depth of several feet—it has the characteristics of quicksand and is extremely dangerous to cross. Such places have been used by only a small number of spawning salmon, and it may be safely asserted that they are now wholly unfit for the deposit of spawn. In the streams and unnamed creeks of the southern end of the island, very little of this material remains, and what little was found in the streams during the summer consisted almost entirely of sand, which can hardly be considered more injurious to the spawning beds than the ordinary sediment and slime so generally present in these streams, particularly those that are lake fed.

That the spawning beds were temporarily injured can not be denied, but the continual flow of water during the winter was sufficient to remove most of the objectionable material. This fact was demonstrated by the presence of an unusual number of young cohos in all streams this season. However, from examinations of streams and lakes at Seal Bay, Paramanoff, and Malena, it is believed that but comparatively few sockeyes ascended to the spawning grounds. These observations were made the latter part of July and early in August, after the run was practically over.

An examination of Letnik Stream was made from May to July during the migration of sockeye yearlings to determine the effect upon young salmon of the eruption of Katmai Volcano the year before. Collecting stations were established at the foot of the lake and at the head o the bay, about 2 miles below where the stream enters salt water. The number of young salmon collected was so very meager as to justify the conclusion that there had been a heavy loss, due no doubt to the fact that only a few adult salmon reached the spawning grounds the previous season when the eruption occurred. Tests made on Letnik Lake showed that there is now an ample supply of the small form of crustacean upon which young salmon feed.

The project of stocking Afognak Island with reindeer was not consummated this year, delay being deemed desirable to permit of a better growth of moss following its destruction by the volcanic eruption of 1912. Under normal conditions, Afognak Island should be well adapted to the propagation of reindeer, and their introduction will, it is believed, prove a pronounced and direct boon to the natives, as well as an indirect benefit to the other inhabitants of the island.

Dolly Varden Trout.

A noteworthy catch of Dolly Varden trout was made at Paramanoff, where 1,300 were taken in two seine hauls about July 20. These fish weighed approximately 1½ pounds each and had an average length of about 16 inches. The other fisheries produced a few Dolly Vardens of the same average size, and in some instances, particularly at Malena, examples were taken weighing some 10 pounds each. It is a peculiar

circumstance that these larger fishes are rarely seen in the streams and lakes, though the smaller ones are quite numerous.

Ever since the inception of fish-cultural work on Letnik Lake, Dolly Varden trout have been very abundant, and that fact has presented a serious problem in connection with the proper disposition of hatchery fry. Rearing to the fingerling stage so far as circumstances and facilities will permit is the solution of the difficulty. In the spring of 1910 it was observed that the hatchery stream was literally teeming with Dolly Varden trout of uniform size and weight. The average length was from 10 to 12 inches and the weight from 8 to 10 ounces. An examination of the stomachs of many taken in seines revealed the fact that they were gorged with salmon fry, and their excellent condition was added proof that they had been well fed during the winter. In October and November, 1911, thousands of Dolly Vardens gathered at the outlet of the flume discharging from the hatchery and were taken by seines, as many as a small dory full at one haul. These fish were of all sizes, but the average length was about 10 inches and weight a third of a pound. Throughout the winter wire traps were set for them, and in this manner several hundred more were destroyed.

The construction of barricades to prevent the incoming of Dolly Vardens from the sea is of doubtful value. From observations of Letnik stream it would seem that there is more of a movement from the lake to the sea than from the sea to the lake. Since Dolly Vardens are not known to spawn in salt or brackish water, their presence there can be accounted for only by the obvious fact that they descended from fresh water. Thus a barricade would have the effect of retaining the undesirable Dolly Vardens in the waters of the lake. During the past summer while an examination of Letnik stream with reference to the migration of young salmon was being made, the presence of many Dolly Vardens above the rack was noted, but none could be seen below it. Some approached too near the rack and were drawn between the slats, where they died. From May 26 to June 9 more than 500 were thus destroyed.

The extermination or at least great destruction of Dolly Vardens in Letnik Lake can probably be best accomplished by netting them at the mouths of the streams where they congregate during the spawning season in September and October. It is reported that at the Afognak hatchery this year Dolly Varden trout have been notably scarce. This may be due either to the seining operations in the fall of 1911 or the volcanic eruption in 1912, or to both causes.

HATCHERIES.

EXTENT OF OPERATIONS.

Seven salmon hatcheries were operated in Alaska during the season of 1913. Of these, two are operated by the Government and five by

private companies. The two Federal stations are located at Yes Lake and on Afognak Island. There were also two small temporary experimental field stations operated by the Government, one at Eagle Lake and the other at Uganik Lake, both on Kodiak Island. Of the private establishments, the Alaska Packers Association has one on Naha stream and another on Karluk River; the Northwestern Fisheries Co. has plants at Quadra Lake and at Hetta Lake, while the North Pacific Trading & Packing Co. and the North Alaska Salmon Co. operate jointly a hatchery at Klawak.

The largest of the hatcheries is the Fortmann plant on Naha stream, with a normal capacity of 110,000,000 red salmon eggs. The Government stations are each adapted to the handling of about 72,000,000 eggs. The Karluk hatchery can handle comfortably 48,000,000, Quadra 17,000,000, Hetta 12,000,000, and Klawak 10,000,000. These figures represent normal capacity, and if necessary a very material increase can be made by putting more eggs in each basket. The basket of usual size holds 60,000 red salmon eggs, though 70,000 or more may be crowded in if urgently required. In the latter event they are more difficult of manipulation. The total hatchery capacity in Alaska is now approximately 350,000,000 red salmon eggs per year. There has been no change in the number of permanent stations operated since the completion of the Government hatchery at Afognak in 1908.

The season of 1912–13 resulted in a collection of 167,189,470 red salmon eggs, from which 150,970,355 fry were released. This was a pronounced falling off from the total of 240,597,800 fry released the previous season. The season of 1913–14 is still less productive, as the total number of red salmon eggs collected was only about 134,000,000.

Following is a table of hatchery operations for the 1913 season:

Operations of Alaska Hatcheries in 1913.

Stations.	Red or sockeye salmon eggs taken in 1912.	Red or sockeye salmon fry liberated, 1912–13.	Per cent of loss.	Red or sockeye salmon eggs taken in 1913.
Yes Lake	66,125,000	60,422,100	5.5	[1] 49,050,000
Afognak	14,689,470	12,551,100	14.5	[2] 10,989,000
Eagle Lake				2,180,000
Uganik Lake				1,970,000
Fortmann (Naha)	23,160,000	20,800,000	10.1	9,480,000
Karluk	45,600,000	41,803,155	8.3	34,629,160
Quadra	10,000,000	8,127,000	18.7	18,400,000
Hetta	3,780,000	[3] 3,592,000	4.9	[4] 4,082,000
Klawak	3,835,000	3,675,000	4.1	3,645,000
Total	167,189,470	150,970,355		134,425,160

[1] Also 5,280,000 humpback eggs taken at Ketchikan substation.
[2] A collection of 13,900,000 humpback eggs also made.
[3] Includes 542,000 fry planted after July 1, 1913, but here included to show product of 1912 take of eggs.
[4] Last report received; later figures will show slightly increased take.

Note.—Of the Yes Bay collections, 2,000,000 sockeye eggs were shipped in the fall of 1912, also again in 1913, to the Oregon Fish Commission

HATCHERY REBATES.

A credit upon the Federal fishery tax in Alaska is allowed operators of private salmon hatcheries at the rate of 10 cases of canned salmon, or the tax equivalent of 40 cents for every thousand red or king salmon fry liberated. This is an equitable rate, as it has been found that year in and year out it costs on the average nearly 40 cents to produce 1,000 healthy red salmon fry at the private hatcheries. The rebate system, however, has met with some disfavor at the hands of Alaska people, and apparently the time will come when all private hatcheries in Alaska will be taken over by the Government, fair compensation therefor being allowed present owners. This plan meets with the approval both of the Bureau of Fisheries and the owners of hatcheries, and legislation by Congress on the subject may soon be expected.

It is now provided by law that returns of the number of fry released must be made under oath by private salmon hatchery operators for each year ending June 30. The following table shows the rebate certificates allowable for the fiscal year ended June 30, 1913:

REBATES CREDITED TO PRIVATE SALMON HATCHERIES DURING FISCAL YEAR ENDED JUNE 30, 1913.[1]

Owners.	Location.	Red salmon fry liberated.	Rebate due.
Alaska Packers Association	Naha stream	20,800,000	$8,320
Do	Karluk River	41,803,155	16,721
Northwestern Fisheries Co	Quadra Lake	8,127,000	3,250
Do	Hetta Lake	3,592,000	1,436
North Pacific Trading & Packing Co., and North Alaska Salmon Co.	Klawak Lake	3,675,000	1,470
Total		77,997,155	31,197

[1] In the case of the hatcheries where the seasonal distribution of fry is not completed before July 1, the remaining fry are shown in the subsequent fiscal year's report.

HATCHERY INSPECTION.

Instead of the customary annual inspection of the private hatcheries in Alaska, this year representatives of the Bureau of Fisheries visited these plants two and in some instances three times during the season. This is in line with the new policy of keeping in closer touch with the work as conducted at these stations, although the general annual inspection heretofore made, together with other sources of information, sufficed to check up very closely the output and activities of each hatchery.

YES BAY.

During the 1912–13 season at the Yes Bay station, 66,125,000 red salmon eggs were taken. This was a falling off of 5,875,000 from the previous season's take. It is estimated that the take would have

been 75,000,000 had not a number of spawning salmon escaped by reason of high water. Plants aggregating 60,422,100 fry were made during the first six months of the year 1913. On October 22, 1912, a shipment of 2,000,000 eggs was made to the Oregon Fish Commission. It is through the month of September that practically all of the eggs are taken at Yes Bay. During the 1913–14 season the aggregate number of red salmon eggs secured was 49,050,000. Of this year's collection, a shipment of 2,000,000 eggs was also made in October to the Oregon Fish Commission.

The salt solution was again used this season very successfully in removing any dead eggs occurring in the baskets, thus effecting a great saving in labor as compared with the old process of hand picking. Most of the eggs were run through the solution during the month of November. The eggs taken during the early part of the season when the water is warmer begin to hatch when about 80 days old, while the eggs taken near the end of the season when the water is cooler do not begin to hatch until when about 140 days old. The mean temperature of the water during the period of incubation at the Yes Bay station averages about as follows: September, 51⅔°; October, 46½°; November, 38½°; December, 35⅓°; January, 32¼°; February, 33⅗°, and March, 33° F.

Restrictions of commercial fishing operations on Yes Bay were enforced this year as usual. The purpose of this is to permit a sufficient escape of spawning salmon to supply the needs of the hatchery. In line with the present-day policy to feed young salmon before planting, several ponds have been in process of construction with the close of the calendar year at the Yes Bay station. Also last year 160 fry troughs were constructed and placed in position under the hatching troughs for the purpose of holding a larger number of young fish in the hatchery.

Early in the year two experimental troughs were constructed, one with a very smooth bottom while the other was rather rough. These were painted with asphaltum and fry were placed in each to ascertain any possible difference that the condition of the bottom might have upon them. It developed that in the case of the smooth-bottomed trough the fry remained near the head and but few died, while in the rough-bottomed trough the fry seemed uneasy and kept working down to the foot screen. The loss in this trough was much greater than in the one with the smooth bottom. This experiment seems to show the necessity of having a smooth bottom in all troughs containing fry.

For the purpose of collecting humpback eggs, a temporary field station was installed at Ketchikan. New troughs with a capacity of 6,000,000 eggs were built and baskets were transferred from the Yes Bay station. The water supply came from a near-by power flume.

Operations were confined chiefly to the month of September, when collections aggregated 5,280,000 humpback eggs.

During the month of May, 1913, observations were made in a limited way by the superintendent of the Yes Bay station for the purpose of obtaining information as to the number of young sockeye salmon passing into Yes Bay. At 6 o'clock on the evening of May 4 a small net was placed in Yes River, just above tide water, at a point near the cannery. One end of the net was made fast ashore and the other end was attached to a large rock only 3 feet out from the same shore. At 8 o'clock on the following morning this small section of net contained 1,310 yearling sockeye salmon, averaging 3 inches in length. The river at this point is about 20 feet wide. The next night a net was set near the foot of the lake where the river at the time was about 50 feet wide. The net in this instance covered about 10 feet of the stream. It should be noted that the lead line was about a foot from the bottom. The next morning 575 yearling sockeye salmon were taken from the net. On May 16 this net was again set near the foot of the lake, but owing to very high water only 50 yearling sockeyes were caught. All fish taken in the three sets were in excellent condition.

The fact that a small piece of net only 3 feet long, set in a stream 20 feet wide, will catch 1,310 sockeye yearlings in one night would seem to be very good evidence that the aggregate number of young salmon thus moving to the sea during the entire period of the spring migration is of highly satisfactory proportions. That the Yes Bay hatchery is a potent factor in this result almost goes without saying, as practically all of the sockeyes passing into Yes Lake are spawned at the hatchery.

TABLE OF THERMAL RECORDS AT YES BAY STATION.

Date.	Air.		Water.		Rain.	Snow.
	Maximum.	Minimum.	Maximum.	Minimum.		
1912.					*Inches.*	*Inches.*
July	79	54	64	50	4.41	.....
August	73	51	61	49	5.15	.....
September	68	32	59	47	14.99	.....
October	53	33	49	42	19.01	.....
November	49	25	44	35	14.55	1.00
December	49	25	39	33	12.84	45.40
1913.						
January	38	−2	34	32	4.78	64.70
February	38	18	34	32	6.57	5.95
March	42	12	36	32	7.37	7.35
April	53	33	41	32	7.79	5.40
May	61	37	41	34	6.42	.....
June	70	44	50	38	2.94	.....
Total	.....	.....	.....	.....	109.82	129.80

Afognak.

At the Afognak station during 1912 the take of red salmon eggs numbered 14,689,470. In addition, 3,271,740 humpback eggs were taken. Plants of sockeye fry made principally during February and March, 1913, aggregated 12,551,100. The loss during the period of incubation was 14½ per cent. So much trouble was caused by heavy deposits of fine sediment in the fry troughs that it was deemed best to plant the young fish early in the season at places about the lake where the streams did not wash in quantities of ash. The take of eggs was greatly lessened by the loss of spawning fish following the fall of ash from the Katmai volcanic eruption June 6 to 9, 1912. This same influence has undoubtedly been responsible in considerable measure for the lessened take during 1913, when but 10,989,000 sockeye eggs were obtained. The take of humpback eggs was larger, numbering 13,900,000. While the propagation of sockeye salmon is more to be desired when spawning fish are available, there is nevertheless a very good field in Alaska for the propagation of humpbacks. It has been shown that the propagation of cohos is not advisable, at least in conjunction with sockeye operations, as many of the young cohos remain in fresh water for a year and prey upon the sockeyes. The humpbacks, however, go to sea soon after hatching.

No fish-cultural operations were undertaken at Malena Lake this year, as an inspection during the month of August disclosed that the spawning creek at the head of the upper lake was almost filled with volcanic ash.

Eagle Lake.

With a view to expanding fish-cultural work in the Afognak-Kodiak region, experimental operations were undertaken this year under direction of the superintendent of the Afognak station at Eagle Lake, which is a few miles from Eagle Harbor on the south side of Kodiak Island, and about 60 miles from Afognak. A barrier was put across the river a short distance below the outlet of Eagle Lake in order to make an accurate count of the number of salmon entering its waters. As a result, it was ascertained that from July 1 to August 12 a total of 5,416 sockeyes and 1,811 humpback salmon passed into the lake. Temporary hatching troughs were set up, and from August 14 to September 1 a take of 2,180,000 sockeye eggs was made. The eggs were cared for until well eyed and with the approach of cold weather, which necessitated discontinuance of this experimental work, the eggs were planted at appropriate places in the lake.

During the course of the season's operations upwards of 5,000 Dolly Varden trout were destroyed.

Under present conditions it is not believed that Eagle Lake offers a suitable place for fish-cultural operations. The water is impreg-

nated with volcanic ash, the result of the Katmai eruption of 1912, and as a result successful hatchery operations on an appropriate scale are practically impossible, or at least appear to be until such time as the ashes have become incorporated with soil and erosion shall have ceased. The new growth of vegetation is improving conditions in this regard.

Uganik Lake.

Experimental hatchery operations were also conducted this season as an adjunct to the Afognak work at Uganik Lake, which place is about 40 miles from Afognak.

At the beginning of the season a barrier was put across the river between the lake and the bay in an effort to get an accurate count of the fish entering the lake, but on account of swift current and for other reasons it was impossible to maintain the barrier. During the period from August 7 to September 8 a total of 1,970,000 sockeye eggs were taken and placed in temporary hatching troughs. With the approach of cold weather, when the eggs were well eyed, they were planted in gravel in suitable lagoons of the lake.

The result of the experiment at Uganik seems to justify the conclusion that a suitable site is afforded for a moderate-sized salmon hatchery. The sockeyes at Uganik have long been recognized for their superior size. It is reported that about 48,000 sockeyes were taken by commercial fishing interests this season from Uganuk Bay.

Fortmann.

The Fortmann hatchery of the Alaska Packers' Association is located on Heckman Lake of the Naha system, 8 miles above Loring, in southeast Alaska. It is the largest salmon hatchery, public or private, in the world, having a capacity of upwards of 110,000,000 red-salmon eggs. During the 1912–13 egg collecting season 23,160,000 eggs of this species were taken, from which during 1913 a total of 20,800,000 young fish were liberated, the loss being a little over 10 per cent. The fry passed from the hatching troughs into nursery ponds, where they were fed on fish prepared for the purpose, and after they had attained a growth which enabled them to move about in strong and vigorous fashion, they were allowed to pass from the ponds into the Naha stream system of lakes and connecting waters, most of them to remain there through one winter before going to sea.

The egg-taking season of 1913, which extended from August 24 to October 16, resulted in the collection of but 9,480,000 red-salmon eggs. This is the poorest take in the 13 years the station has been operated. The situation simply was that the run of breeding salmon did not materialize, and bore out the fishing records as well as the returns at other hatcheries, Quadra excepted, that southeast Alaska had an off year for red salmon. At Quadra, about 60 miles south of

the Fortmann hatchery, the take of 18,400,000 eggs was better than ever before.

On the theory that most of the red salmon in Alaska return when 5 years old, some interesting comparisons are possible by going back a few years in the record of eggs taken at the Fortmann hatchery. In 1906 the take was 105,000,000 eggs, while five years later in 1911 it was 107,000,000. The 1907 take was 41,000,000 and that of 1912 was 23,000,000. In 1908 the take was 24,000,000 and 1913 produced but 9,000,000 eggs. Round figures only are given.

Thus it will be seen that there is a much more pronounced corollary in the five-year cycles than in the four-year periods. If the five-year cycle theory is a correct index, as it seems to be, a light take was to be expected for 1913, since 1908 was a poor season, comparatively speaking. Carrying this reasoning to future years, 1914 ought to be better, as the 1909 take was 53,000,000; then might come a poorer take in 1915, as the 1910 collection dropped to 34,000,000. Then in 1916 should come a heavy run, for in 1911, five years before, the take was 107,000,000, while in 1906, another five-year cycle back, the take was 105,000,000. These figures certainly form the basis for interesting speculation, both as to the take of eggs at the hatcheries and the runs of red salmon that may be anticipated by the cannerymen.

Karluk.

At the Karluk hatchery of the Alaska Packers' Association, located on Kodiak Island, the season of 1912–13 was productive of 45,600,000 red-salmon eggs, from which in 1913 a total of 41,803,155 free-swimming fry were liberated in the Karluk River. The loss was thus 8½ per cent. The 1913–14 season resulted in a take of 34,629,160 red-salmon eggs, the period of collection extending from June 21 to October 11. Each female produced on the average 3,109 eggs.

Quadra.

Egg taking for the season of 1912–13 at the Quadra Lake hatchery began August 16 and was completed November 12, 1912. From 3,135 females there were obtained 10,000,000 eggs, an average of 3,190 per fish. The eggs eyed in from 42 to 55 days and the hatching period varied from 111 to 135 days. Water temperatures ranged between 36° and 42° F. From the take of 10,000,000 eggs a total of 8,127,000 fry resulted. The first plant occurred December 7 and the last April 7. A total of 7,000,000 fry were liberated in the three ponds adjoining the hatchery, 897,000 went into the hatchery creek and the remaining 230,000 were carried overland to a stream tributary to Marten Arm.

An interesting fact in connection with the take of eggs is that out of the 2,145,000 eggs taken from August 16 to September 2, only

1,000,000 fry resulted, a loss of 56 per cent. These eggs were taken by the old process, and were allowed to stand in pans too long before washing up. They were also subject to shock from concussion during the very tender period of an hour or so while water hardening.

From September 3 on to the end of the season the remaining 7,855,000 eggs were taken by the modified process of incision and immediate washing, and there was a loss of but 720,000 or approximately 9 per cent. This is a positive demonstration of the pronounced value of the new method of egg taking as compared with the old.

Finishing touches, including painting, have been made to the new hatchery building erected in June, 1912, upon the site of the old building. The new structure is 87 feet long and 24 feet wide, has 10-foot walls, and is provided with a gable roof. The building is 6 feet wider and a few feet longer than the old structure, and is devoted entirely to hatchery work. In the old building a section of 12 feet at one end was partitioned off as quarters for employees. A separate building, 16 by 24 feet, has since been erected for use as a dwelling. The equipment of the hatchery, which formerly consisted of 30 troughs of two lengths, has been supplemented by the construction of 20 additional troughs. The normal capacity of the station is now about 17,000,000 red-salmon eggs. Another fry pond has been in process of construction this summer.

The take of eggs for the 1913–14 season began August 11, and resulted in a collection of 18,400,000 eggs. This is by far the largest number in the history of the station. When egg taking was discontinued because of lack of further hatchery space it was estimated that there were still fish enough in the lake for 4,000,000 eggs. The hatchery barrier was removed and these fish were allowed to go up stream to spawn naturally.

Judging by fishing operations, also by egg collections at the Fortmann and Yes Bay stations, the run of red salmon in southeast Alaska was lighter than usual. It would seem that the explanation of the very heavy take at the Quadra hatchery lies in the fact that fishing operations off the stream at the foot of the lake were prosecuted less vigorously this season than heretofore and more spawning fish got up to the lake. This suggests the urgent need of caution in not fishing too close to the stream mouth in future.

Hetta.

During the period from September 1 to December 14, 1912, a take of 3,780,000 red-salmon eggs was made at the Hetta hatchery. A total of 1,265 females were handled for an average of slightly under 3,000 eggs each. The eggs were of very good quality, the loss of 188,000 running under 5 per cent. Up-to-date methods of fish culture were followed. The first fry were planted March 1 and the last July 16, 1913, the total number liberated being 3,592,000. The

season at Hetta is long drawn out by reason of the late take in the fall, and cold water during the winter which retards development.

Egg taking for the 1913–14 season began August 8, which is the earliest take in the history of the station, and at last reports 4,082,000 red salmon eggs had been secured. The take of eggs at Hetta has dwindled considerably during the last few years, and the cause is ascribed to overfishing of Hetta Inlet.

It has been suggested that fishing should be prohibited inside of a line from Graveyard Point to Moses Point, thus allowing many more spawning salmon to get up to the lake. The area mentioned is not more than 500 yards across at the widest place, and it is here that the fish school preparatory to ascending the stream. As high as 14 purse seines were operating at one time this season in the region mentioned and just outside. An examination of the records shows that the catch of red salmon in this section in 1911 was about 51,000, in 1912 it was 60,000, and in 1913 it numbered approximately 50,000. The keen competition of so many different crews means a continuance of fishing throughout the long hours of daylight and its conduct in a manner that will put the utmost number of fish into the boats. Distance restrictions are doubtless worked to the fullest limit of the law. Indeed it would be very strange if there were not some who were not overly scrupulous in this regard. In any event the conformation of the bay which receives the stream at Hetta permits the laying out of seines in a manner not violating the law and yet effectually deterring any considerable number of fish from reaching the stream.

It is believed that while the statistics of the catch of sockeyes for southeast Alaska indicate a continuance of the supply, these figures really point to increased activity in the pursuit and that in small streams like the one at Hetta where an active seine fishery is conducted up to the 100-yard limit, there must eventually be depletion.

To insure a good supply of salmon at the Hetta hatchery there should be at least a 500-yard zone off the stream mouth where no commercial fishing shall take place. It has been stated by A. J. Young, superintendent of the hatchery, that if all commercial fishing were prohibited off Hetta Inlet up to July 1 of each season, the June run of sockeyes would thus be permitted to reach the lake and a good take of eggs would follow. Mr. Young's opinion is well worth careful consideration, as he has long been familiar with conditions in the region, both as a commercial fisherman and hatchery employee.

The improvements of a fixed character begun in 1912 were completed this year. The old hatchery building was torn down and a new building was erected on the lake front near the old site. The new building is 66 feet long, 34 feet wide, and has 10 foot walls. It has a shingled gable roof and is lighted by 12 windows. The same troughs and such lumber from the old building as could be utilized were put

into the new building. Water from the spring which supplies the hatchery is conveyed through a new 4-inch log pipe line 310 feet in length. The hatchery is heated by two large stoves. If required, there is ample floor space in the new building for the installation of a number of additional hatching troughs. A new dwelling for employees has also been erected. This is a single-story building 20 by 24 feet, containing three rooms. Both new buildings have been neatly painted. A notable improvement under way late this season is a large pond in which fry may be placed and fed before final liberation. Heretofore all plants have been of fry. The construction of this pond is in line with modern ideas of rearing young salmon before planting.

Klawak.

During the 1912–13 season at Klawak, egg taking began August 16 and was completed September 29, 1912. A total of 3,835,000 eggs were taken from 1,434 female red salmon, or an average of 2,675 per fish. The eggs were taken by the modern method of incision and proved to be of very good quality, the loss during incubation being 160,000 or only a little more than 4 per cent. The first plant of fry occurred November 28, 1912, and the last February 4, 1913. The total of the plants was 3,675,000. The approximate mean temperatures of the hatchery water supply during the season were as follows: August, 51° F.; September, 50°; October, 46°; November, 40°; December, 38¾°, January, 38°, and February, 38°.

Heretofore the output of the hatchery has been liberated in the form of fry, but this summer a pond 16 by 24 feet was constructed and in future a part of the output at least will be fed and the fish will be released when 2 inches or so in length. Additional pond space is required here as at all of the Alaska stations to give sufficient room for the rearing of young salmon.

The take of red-salmon eggs during 1913–14 season at Klawak numbered 3,645,000. Egg-taking operations were confined to the months of August and September, when all told 1,215 fish were stripped.

Etolin Island.

The hatchery, which was operated for 14 years as a private enterprise by Capt. John C. Callbreath, on waters tributary to McHenry Inlet, has been closed since 1906. However, up to the present season, it has been the custom to lift over the barricade on the stream all red salmon which endeavored to reach the spawning grounds above. Capt. Callbreath was a strong believer in the parent stream theory, and thought to build up a strong run of reds by excluding and destroying the humpback salmon, which species also ascended to the dam in considerable numbers. He thought that the destruction of the humpbacks would mean more food for the young red salmon

during their sojourn in the lake. Recent observations have clearly demonstrated the absurdity of the view that destroying humpback salmon will conserve the fry food in a lake. The humpback fry do not feed in fresh water, but go to sea as soon as able to swim. The destruction of this fish can accomplish no useful purpose, and is a plain violation of the wanton waste section of the law.

Upon the assumption that Capt. Callbreath's practice of destroying humpbacks during the last few years arose from a misunderstanding both of the habits of the salmon and of supposed private rights acquired by the maintenance of a hatchery during earlier years on the stream in question, the Bureau invited the citation of any documentary proof of a grant or privilege exempting the stream from the operation of the general fisheries law, under which law the maintenance of a barricade is a punishable offense, as is also the wanton waste of salmon. No such proof of exemption being forthcoming, the barricade in the stream was destroyed this season, and the waters assumed the status of other open streams in southeast Alaska. The last salmon were put over the barricade in 1912, and numbered 2,435 adult sockeyes, of which 1,282 were males and 1,153 females.

The efforts of Capt. Callbreath afford a most interesting sidelight on the history of the Alaska salmon fisheries, and since their value from a scientific viewpoint is considerable, it is the more unfortunate that the heavy expenditure of time and money involved should have been proportionately so unprofitable in a practical way.

HATCHERY METHODS.

Within the last few years there have been certain radical departures in the methods of spawn taking. To insure thorough understanding of these, it seems appropriate to bring the matter to attention at this time.

Each ripe female salmon should be killed by a blow on the head, following which an incision should be made in the abdominal wall from the pectoral fins to the region of the vent. The eggs will flow in a mass into the spawning pan placed beneath. Immediately after being fertilized they should be washed by immersing in the stream and pouring the water off. Repeating the process two or at most three times will be sufficient. It is entirely unnecessary to have the eggs remain in milt and water any longer than is required in the washing process following immediately after the application of the milt.

After washing, each pan of eggs should be poured into a bucket partly filled with water and placed in the bed of the stream where the water is several inches deep, so that the temperature in the bucket will be the same as that of the stream. After filling the bucket about half full of eggs, it should be allowed to remain undisturbed for about an hour, or until such time as the eggs have become fully water hardened and are entirely separated. While standing in

the bucket the eggs will absorb sufficient water to increase their size about 40 per cent, hence the buckets must not be filled over half full.

During this period of absorption the eggs are extremely sensitive and must remain absolutely undisturbed. The process of handling eggs by the improved methods now in vogue is described in some detail upon pages 80–82 of the Alaska Fisheries Report for 1911.

In connection with hatchery operations, attention is again called to the fact that greater care ought to be exercised in planting young fish.

A feeling has often prevailed that responsibility at the hatchery ceases when the fish are ready for planting. Greater caution and care, and more intelligent thought should be devoted to the selection of suitable places for the release of the hatchery product. Rather than promiscuous dumping of the fish in open lake waters, it would be much better to select protected tributary streams wherein to release them, guarding, however, against places infested with trout or other destructive agents. No fish culturist would think of having even one Dolly Varden trout in the rearing pond or hatching trough containing young salmon, in fact every means at his command would be exercised to remove the trout; yet the next day, perhaps, he will complacently carry out several hundred thousand fine young salmon and unhesitatingly dump them into waters where trout abound, often making no effort to destroy a single one of the trout.

Setting gill nets off the mouths of streams wherein plants are made is a good way to destroy trout. On every lake where fish-cultural operations are conducted, gill nets or suitable forms of traps ought to be in the water every month of the year—even set beneath the ice—to catch Dolly Varden or other species of trout. By this means thousands of young salmon will be saved.

Hatchery work is highly perfected up to the time of planting, but there is room for improvement in the latter operation. This matter was referred to more fully in the Alaska Fisheries Report for 1911, pages 86 to 88.

NEED OF ADDITIONAL HATCHERIES.

Hatcheries have done much good in the way of preserving the salmon industry in the face of heavy fishing. No one can state definitely what would have happened had there been no fish-cultural effort, but considering the great saving over nature's method it seems indisputable that there has been a proportionately increased production of young fish, the result of artificial propagation. A tendency has existed, however, in some quarters to consider hatcheries as a cure-all for every evil, past, present, or future. But it is only reasonable to say that along with hatcheries must go a proper regulation of fishing, else benefits are to a greater or less degree annulled.

The two Government and five private hatcheries in Alaska are doing good work even in the face of an ever-increasing commercial

demand for red salmon. Recent advances in the science of salmon culture, including the planting of fingerlings rather than fry, will make hatchery work still more helpful. Alaska now needs at least five additional hatcheries, two in the Bristol Bay region, one in the Chignik section, and at least two more in southeast Alaska—one perhaps in the vicinity of Sitka and the other on the Chilkoot.

GENERAL STATISTICS OF THE ALASKA FISHERIES FOR 1913.

The total investment in the Alaska fisheries in 1913 was $37,047,305, a decrease of $1,216,152 from 1912. Approximately 85 per cent of the investment was in the salmon industry. The number of persons engaged in 1913 was 21,721 as compared with 24,263 in 1912, a decrease of 2,542 persons. The total value of the products in 1913 was $15,739,068 as against $18,877,480 in 1912, a decline of $3,138,412. The principal item in the decrease was canned salmon.

SUMMARY OF INVESTMENTS IN THE FISHERIES OF ALASKA IN 1913.

Industries.	Southeast Alaska.	Central Alaska.	Western Alaska.	Total.
Salmon canning	$11,946,974	$5,920,255	$13,474,441	$31,341,670
Salmon pickling	61,439	88,858	295,080	445,377
Salmon mild curing	1,107,911	36,360	21,595	1,165,866
Herring fishery	259,725	1,755	.....	261,480
Halibut fishery	2,360,025	.....	.....	2,360,025
Cod fishery	.....	581,107	.....	581,107
Whale fishery	891,780	.....	.....	891,780
Total	16,627,854	6,628,335	13,791,116	37,047,305

SUMMARY OF PERSONS ENGAGED IN THE FISHERIES OF ALASKA IN 1913.

Races.	Southeast Alaska.	Central Alaska.	Western Alaska.	Total.
Whites	5,750	2,026	4,116	11,892
Natives	2,949	598	617	4,164
Japanese	868	254	571	1,693
Chinese	875	328	858	2,061
Miscellaneous	338	316	1,257	1,911
Total	10,780	3,522	7,419	21,721

SUMMARY OF PRODUCTS OF THE ALASKA FISHERIES IN 1913.

Products.	Quantity.	Value.	Products.	Quantity.	Value.
Salmon:			Cod.....pounds..	11,916,900	$357,711
Canned.....cases..	3,739,185	$13,531,604	Herring.....do....	10,413,926	106,105
Mild-cured....pounds..	6,012,486	543,362	Herring oil.....gallons..	260,000	52,000
Pickled.....barrels...	38,332	279,249	Herring fertilizer..pounds..	2,400,000	33,000
Fresh (including local), pounds.....	820,956	65,727	Whale oil.....gallons..	466,500	139,950
Frozen.....pounds..	701,418	28,057	Whale fertilizer....pounds..	1,330,000	17,600
Dry-salted.....do....	121,282	1,235	Trout.....do....	51,633	3,660
Halibut:			Black cod.....do....	49,144	2,494
Fresh (including local), pounds.....	3,642,163	114,277	Miscellaneous fresh fish, local.....pounds..	75,000	6,000
Frozen.....pounds..	9,987,310	454,320	Total.....	.....	15,739,068
Dry-salted.....do....	21,159	830			
Fletched.....do....	37,152	1,887			

SALMON FISHERIES.

FISHING CONDITIONS.

Southeast Alaska.

In southeast Alaska this year there was a pronounced scarcity of red salmon as compared with the previous season, cannerymen on the average getting only about one-fifth as many reds. At one or two canneries in the Icy Strait region the pack of reds was larger this year. Generally speaking, southeast Alaska had a satisfactory season for pinks, although some of the traps in the Ketchikan section did not do very well, except during one rather short period, stormy weather causing considerable damage to the gear and lessening the catch. During the period when the run was at its height many of the purse-seine boats were on limit.

There were no serious disturbances in the way of strikes by fishermen this year, as had been the case in 1912. None of the large power-seine boats from Puget Sound invaded southeast Alaska to fish through the season for salmon. Prospects were much more alluring nearer home, and, moreover, it was demonstrated in 1912 that the large deep-water purse-seine rig is rather too unwieldy for profitable operation on many of the smaller arms and reaches of southeast Alaska waters.

In Icy Strait there was no heavy run of chum salmon early in the season as was the case in 1912. On account of the low price, most of the canneries made no effort to can chums; in fact, in many instances fishermen were instructed to return them alive, if possible, from the seines or other gear used. No doubt there was a considerable waste of chums in some places. Investigations were made in two instances where it was reported that the waste was of a most wanton character, but sufficient evidence could not be adduced to justify prosecution. At some of the plants only the best and brightest of the chum salmon were canned, those remaining being given to the Indians for food, or disposed of to halibut fishermen for bait. The cold-storage plants took quite a number of chums, and the shipment fresh to Seattle also afforded a means for disposing of the not over-esteemed chum salmon in southeast Alaska this season. At a number of the canneries as much effort was made to pack chums as the other species. It may be said that this proved not an unwise course, for late in the fall the price of chums advanced. This was brought about by the demand for chums to round out orders and thus help sell the better grades.

In southeast Alaska most of the canneries outfitted for a lighter pack than the previous year, in consequence of which operations, generally speaking, came to a close much earlier than usual. Some of the packs were completed the latter part of August. The low

price and big pack anticipated on Puget Sound had much to do with shortening the season.

There were a few storms in southeast Alaska during the fore part of the season and again toward the close, but for two weeks in August there was even no rain in the Ketchikan region. The creeks were low, thus retarding the ascent of salmon, and catches were good. During this period all canneries ran to capacity.

Central Alaska.

Cook Inlet and central Alaska have in general experienced unsatisfactory results this season. There was a good showing of early kings in Cook Inlet, but the heavy run of reds was of very short duration, the fish coming with a rush later than usual and in some instances showing quite an advanced sexual development. Weather conditions were favorable. A striking feature was the almost utter absence of pinks, the season being in this respect like that of 1911. It is reported that later in the season there was a good run of cohos, but the cannerymen did not wait for this run. As in Bristol Bay, it is doubtful whether it will ever be found profitable to await the main run of the late-coming cohos in the Cook Inlet region.

Reports indicate that there was an unusual amount of vegetable growth in the waters of Cook Inlet this season. To this growth there were frequently attached small particles of pumice which had an erosive effect upon wire trap leads. It also formed in a blanket-like mass on the web. Much trouble was occasioned from this source, and its presence was possibly accountable in a measure for the lighter catch this season in Cook Inlet.

In the Karluk region the present season has been comparatively poor. Possibly the Katmai volcanic disturbance in June, 1912, with its widespread deposit of ash over land and sea, may have influenced the run of salmon in central Alaska.

At Chignik the situation has changed considerably. While formerly nearly all of the fish were taken by traps located within the lagoon, a large tidal estuary at the head of Chignik Bay, this year the greatest part of the salmon were caught in traps located far down the shores of the bay. The new order of things has resulted in a lessening of the tension formerly existing between the canneries, due to disputes arising from the locations of traps in the lagoon, and the difficulty of holding a trap in position after it was driven on account of the ice.

Western Alaska.

The favorable weather throughout Alaska meant more perhaps in western Alaska than elsewhere, and, coupled with the heavy run of salmon, made possible the largest pack ever recorded for that region. The previous winter was unusually mild, and when the fleet of can-

nery ships arrived in Bering Sea the fore part of May no ice was encountered, while the earliest comers found the rivers open and the ground almost entirely free from snow and ice. Ordinarily most vexatious delays occur because of the heavy ice floes.

Thus western Alaska had the best season in its history for red salmon. This was the occasion of surprise in some directions, but careful study of the situation might have yielded a correct forecast as to expectations for the season.

True it is that predicting salmon runs is fraught with many hazards, but using certain hypotheses as to cycles of return, and taking into account additional knowledge recently acquired through scale study as to the age of salmon, a forecast of the Bristol Bay runs may be made with what would seem to be reasonable accuracy. For the purposes of these deductions, it must first be accepted that in Bering Sea red salmon return in the fourth and fifth years. Evidence of this is had in catches of recent years; 1908 was a big year, and 1909 was also; 1912 was a big year, while 1913 was still larger. On this basis the four-year fish from 1912 will return in 1916, and the five-year fish in 1917; the four-year fish from 1913 will return in 1917, and the five-year fish in 1918. Thus, of the years 1916, 1917, and 1918 the return in 1917 ought to be the largest, as it will have the benefit of both the five-year fish from 1912 and the four-year fish from 1913. However, 1916 should be a very good season with the return of the four-year fish from 1912, while the 1918 season should also be good, having the benefit of the five-year fish from 1913. Tabulating this we have:

Year of large run.	Return of 4-year fish.	Return of 5-year fish.
1908	1912	1913
1912	1916	1917
1913	1917	1918

The approximate catch of red salmon in the Bristol Bay region during the past 10 years has been as follows:

	Number.		Number.
1904	12,000,000	1909	15,600,000
1905	14,100,000	1910	11,600,000
1906	11,000,000	1911	9,000,000
1907	10,200,000	1912	19,900,000
1908	17,000,000	1913	21,500,000

It will be observed from the foregoing that there are two quite good years followed by a like period of lean production. Thus, 1904 and 1905 were good; 1906 and 1907, light; 1908 and 1909, good; 1910 and 1911, light; and 1912 and 1913, good. Carrying this further, we may reasonably expect 1914 and 1915 to be lean—1915 being the lighter of the two—and 1916 and 1917 to be good seasons.

The northwestern shore of the Alaska Peninsula from Port Heiden southwestward to Nelson Lagoon has attracted the itinerant attention of salmon fishermen for many years. Dating from about the year 1900 several packing schemes have been promoted in a more or less desultory manner. Of these the only one surviving at the present time is the salting establishment at Nelson Lagoon, although operations of a similar character on a small scale were also conducted at Port Heiden this year. It has been commonly conceded that while there are a number of streams in this region having regular runs of red salmon in moderate abundance, their distance from each other and the general lack of refuge for vessels operating on the coast has precluded the location of any large establishment.

In 1911, however, a practical fisherman on a prospecting trip from a cannery then newly established on the south coast of the peninsula, learning of the great masses of salmon which school off the coast between Cape Seniavin and Port Moller, conceived the idea of taking them by means of purse seines. As a result the large cannery at Port Moller, operated this year for the first time, was established. From the report of the superintendent the new departure was so sucessful that the same method of fishing will be depended upon henceforth as the principal means of capture; in fact, he freely predicts that within a few years the greater part of the salmon taken by Bering Sea canneries will be caught with purse seines.

SALMON CANNING.

Changes and Improvements in Canneries and Equipment.

Early during the season of 1913 the two canneries operated formerly in the Bristol Bay region by the Alaska Fishermen's Packing Co. passed into the hands of Libby, McNeill & Libby. One of these plants is located at Nushagak and the other on the west side of Kvichak Bay near the mouth of Graveyard Creek. Also the same company acquired the cannery of the Yakutat & Southern Railway Co. at Yakutat in southeast Alaska. These plants, together with the one operated at Kenai, give Libby, McNeill & Libby four canneries in Alaska. The three canneries purchased this season will be operated under the names used before the transfer of ownership was effected. Libby, McNeill & Libby contracted for the entire output of canned salmon put up this season by the Taku Canning & Cold Storage Co. at Taku Harbor, in southeast Alaska.

Among the western Alaska plants, the cannery of the Pacific American Fisheries at Port Moller was operated for the first time this season. The buildings for this plant were erected in 1912. Extensive improvements were made at the Clark Point cannery of the Alaska Packers Association on Nushagak Bay. Important changes

in the way of new buildings were made at the cannery of the Columbia River Packers' Association, also on Nushagak Bay. Extensive building operations were carried on at the cannnery of the Bristol Bay Packing Co., at Pederson Point, Kvichak Bay. The cannery of the Naknek Packing Co. on Naknek River, was largely rebuilt along modern lines. The work of rebuilding the plant of the Alaska Packers Association at Koggiung was completed during the summer, and this establishment is now a splendid example of the most modern type of cannery. Extensive changes were also undertaken at one of the Alaska Packers Association canneries on the Naknek River.

At a suitable site on the upper side of Pederson Point, on the eastern shore of Kvichak Bay, the North Alaska Salmon Co. this season completed the principal buildings for a new cannery which it is contemplated to operate hereafter in lieu of the cannery at Hallerville on the Kvichak River. The machinery from the latter plant will be moved to the new location. The channel of the river at the old site has silted up to such an extent that the plant is difficult of access even for light-draft boats.

In southeast Alaska the cannery of Swift, Arthur & Co. was used as a mild-cure plant this year, and the name of the firm was changed to the Swift-Arthur-Crosby Co. The combination floating cannery and cold-storage plant on the ship *William H. Smith*, located last season at Saginaw Bay by the Weiding & Independent Fisheries Co., was not operated in Alaska this year. The ship *Glory of the Seas*, operated as a floating cannery in 1912 by the Alaska Fish Co., was sold this season to the Glacier Fisheries Co. and converted into a cold-storage plant. The Alaska Fish Co. absorbed the Oceanic Packing Co. and transferred its operations to the plant built by the latter concern in 1912 at Waterfall, on the west coast of Prince of Wales Island. The cannery was enlarged this year by the Alaska Fish Co.

Among the cannery changes and additions of a more or less extensive nature, mention is made of the construction of buildings and the installation of machinery by the North Pacific Trading & Packing Co., at Klawak, for the manufacture of fertilizer and oil. This company has also erected buildings and installed cold-storage facilities for mild-cure operations.

Fish hopper.—A long stride in advance of customary methods of handling salmon in the fish house was seen at a cannery in the Bristol Bay region this summer. Here, instead of the usual bins or compartments on the outer floor of the butchering room, a great hopper, somewhat resembling the amidship section of a vessel, was built through the center of the room. The outer end of the hopper was higher by about 18 inches than the inner end, the slant or pitch to the floor causing the fish to gravitate to the lower end. In the center of the inner bulkhead was a small port or gate from which the fish

were drawn as desired and fed to the butchering machines set close-by.

The bottom of the hopper at this end being at the same height as the heading table of the iron chinks, no hooking or pewing was necessary. In sorting kings and cohos were readily distinguished by their larger size, while dog salmon, which in Bering Sea run with the reds, were easily separated after butchering because of their paler flesh. The sides and floor of the hopper were of heavy tongue-and-groove planking so tightly joined that the fish-house floor was perfectly dry and clean. For cleaning the hopper a chute led from the lower end immediately in front of the gate down through the cannery floor into the water below. The chute was covered by a grating, which permitted slime to drain off at all times.

There are several advantages in this arrangement, chief of which is the fact that the first fish dumped into the hopper is the first one out; each is butchered in the order of its arrival in the cannery. No fish accumulate in the bottom of a bin or tank, where they may remain all day long before being put in the cans. The hopper idea is an improvement worthy of general adoption.

Filling machines for flat cans.—Pound for pound, there is a larger return from salmon packed in 1-pound flat and half-pound flat containers than in the 1-pound tall can. Heretofore it has been customary to fill the flat cans by hand, but this year machines designed to do this mechanically were taken to Alaska, and their successful operation will no doubt be followed by an increasing output of the more favorably regarded flat packages. The extra labor and time involved in the hand process of filling flat cans have been the difficult features to overcome from the cannerymen's point of view.

Plan to avoid pewing salmon.—There is considerable controversy over the question of pewing or forking salmon, some cannerymen maintaining that after the fish is dead this does no harm and that the pew marks can not be detected later; others hold a contrary opinion and take pains that no fish are pewed or hooked in any part except the head or tail, which are at present waste portions. It is a fact, nevertheless, that too much attention to such details can not be given, for the more tenderly the fish is handled the finer should be the resultant food product. In Bristol Bay, where red salmon are taken in enormous numbers, it is said to be practically impossible to obviate the necessity for pewing except at undue expense, yet since no effort has ever been made to handle them in any other manner, the statement is not conclusive. A packing concern which has recently entered the Alaska field has announced its intention of trying out a scheme devised by an agent of this Bureau whose observations of the methods of the fishery cover a wide range and a long period of time.

Briefly stated, the idea is to equip gill-net boats, trap scows, and transporting lighters with stout bags made of heavy netting, the upper edges of which are strongly reinforced by bolt roping, so that the entire contents of a compartment may be lifted at a single operation. In gill-net boats the bags will hang by their upper meshes over short pins set in the gunwales and thwarts; in scows and lighters they will secure to iron rods set into stanchions, forming compartments of convenient size, each holding probably not to exceed 1,000 red salmon. For removing salmon from drag seines a light, portable gallows from which to operate a hand brail is suggested. Salmon are almost invariably alive when drawn ashore in this class of nets, and it is difficult to pew an individual fish in the head or tail even when an effort is made to do so. The necessity of avoiding it, however, is apparent, as at this time every stab made with a pew leaves an ugly mark in the flesh which shows plainly in the canned product.

Processing Canned Salmon.

Since the more or less general adoption of the so-called sanitary can in Alaska, beginning in 1911, there has been much discussion of new elements of processing, such as time of cooking, temperature, length of exhaust, and other important points. Out of this discussion and resultant activity there has grown a standard of finished product quite satisfactory to both producer and consumer. Cans have been improved, new machinery has been perfected, cannery men say that stale or slightly sour fish can not be packed successfully in the improved sanitary cans, and in fact the whole operation of salmon packing has made notable advances along scientific and carefully thought-out lines. But the end of development, particularly from the producers' point of view, has by no means been reached. Processing methods and the machinery used in connection therewith are still in a state of transition.

The two general classes of processing canned salmon now followed are commonly termed the sanitary and old-style methods. There is also a modified system now somewhat in vogue which combines the old style of can with the more modern method of exhausting and cooking.

Of the canneries operated in Alaska, 52 per cent have installed the so-called sanitary machinery. In southeast and central Alaska there is approximately an equal division as to the number using the new and old styles, but in western Alaska there is a pronounced leaning in favor of the sanitary type.

The principle of rendering the flesh of salmon or other fish sterile and capable of being kept in a condition fit for human consumption for an indefinite period consists simply of treating with heat to a degree and for a length of time sufficient to destroy completely all

organic life—to annihilate the minute organisms and their spores which inhabit the flesh of the fish, as well as those which may enter during the process of packing—and then seal tightly in a container so that there may be no bacteriological development through the admission of air.

A leak in the container will result usually in the formation of gases that will cause pronounced distension of the ends, and it has come to be generally recognized that a swelled or bulged end is diagnostic of spoiled contents. This is a proper criterion for casual and external determination of quality, though it does not always follow that a slightly distended end necessarily means a spoiled can. It sometimes happens that a perfectly good can of salmon may, in the course of its long journey from the cannery to the retailer's shelf, receive jars and jolts that will cause the ends to bulge in a most suspicious manner. No conscientious salesman thinks of offering such a can for sale, and the consequent loss eventually falls upon the packer. The obvious preventive remedy is the creation of a vacuum within the can to insure a continuously collapsed state of the ends. Thus in the processing of salmon there are two distinct steps, the first being that of securing the required exhaust or vacuum, and second, the cooking proper.

Under the old method of canning the first cooking, which takes place immediately after the top has been soldered on the filled can and central vent stopped up, is known as the exhausting process. After the contents have thus been well heated, the top is punctured, permitting the expanded air and the gases liberated by the heat to escape or blow off, and the vent thus created is quickly soldered before the can and its contents can cool and fill up with air again. A strong vacuum is thus secured, as the excess air has been exhausted. This involves an expenditure of considerable time and labor, some little fuel and other materials, and the employment of certain machinery, much of which is done away with by the modern sanitary system of exhausting.

As a modification of the old method, a practice came into vogue in which the filled can, after having the top soldered on, was given its exhaust heat with the central vent open, the small aperture being stopped with solder after the exhausting was regarded as ended. This was accomplished either by use of the old style of cannery equipment in which the filled cans with this vent were given the exhaust heat in the same sort of cooking cylinders or retorts as are used for the final treatment, or by the employment of elongated steam boxes through which the cans with the vent open were slowly conveyed. The principle involved in these cases is the same. With the vent open the excess of air, which it is the aim to expel, or exhaust, escapes gradually and evenly through this opening, and is thus a distinct advantage over

the old-style method of "blowing," whereby more or less of the oils and juices of the fish are violently expelled with the suddenly liberated gases. This loss of juice is certainly a strong argument against the earlier method of processing. Where this practice of blowing is followed it may be detected by the presence of the second solder dot where the vent hole has been stopped. This improvement on the old-style method affects a considerable saving of time and labor; also a little in material. It is a good method if old-style cans are to be used, and has been adopted by a number of cannery men. Others have held back, however, believing that it would not be long before a decided advance in methods of exhausting would occur. Subsequent events seem to have justified their judgment.

The sanitary method which has come into vogue during the last few years has for its features an improved style of can, and in the exhausting process the top is but loosely placed on the can, thus allowing a gradual expulsion of air, as in the vented top of the modified old style.

In the process of exhausting the cans, there is a certain, though perhaps relatively slight, loss of the more volatile oils through vaporization. It is of importance therefore to see that over-exhausting does not occur. Any objection in this direction is probably wholly overcome in a lately perfected vacuum machine which exhausts the cans without heat or steam immediately after they come from the filling machines. There is strong likelihood that this or some form of vacuum process involving the same principle will supplant present-day methods. The new cannery of the Pacific American Fisheries at Port Moller was this season equipped with old-style machinery in anticipation of having the cold exhaust vacuum machines ready for use next year. The merits of this new form of machine lead to the conclusion that it will be generally adopted before long.

A noteworthy exception in the matter of exhausting cans has been in vogue for years at the cannery of the Seufert Bros. Co., The Dalles, Oreg. At this plant the cans are given no exhaust whatsoever. They are sealed tightly, are given a careful cold test for leaks, and then go to the retorts, where they are cooked 70 minutes at 240° F. It is stated that there is no resultant trouble from swells. Possibly there may be some chance of extending this simplified process to Alaska.

Exhaust boxes, varying somewhat in style of construction and arrangement, are the same in both the modified old-style and the present sanitary systems. The methods of processing after exhausting are similar in all systems.

Most of the exhaust boxes used in connection with sanitary cans are about 30 feet long, with the cans traversing the full length seven

times. Each run is supposed to take a minute and a half, with a total of about 10 minutes for a can to pass entirely through the box, but as a matter of fact the time is often nearer 9 minutes. The heat is theoretically supposed to be maintained at the boiling point, but was never found to be in excess of 210° and more often less, usually about 206° to 208°. In one cannery the exhausters were similar in all respects except width, having 9 runs instead of 7. In practice the cans required a full 10 minutes to pass through. The heat was the same. At still another cannery, using the same type of apparatus, the exhausters were 45 feet long and it took 15 minutes for a can to traverse the 7 runs, with the heat maintained theoretically at 212°. This was the first year the sanitary system had been used at this plant, and the management very evidently was not disposed to take any chances with a weak vacuum.

The experience in this regard is interesting. It was soon found that the fish upon leaving the exhaust had dried out alarmingly. A dozen cans carefully weighed beforehand were found to have lost a good half ounce apiece during the passage through the box. This was at a temperature of 210°. The length of one of the boxes was therefore cut down to 30 feet, so that a can was in the exhauster only 10 minutes with the same temperature of 210°. This was found to give a satisfactory vacuum without noticeable loss in weight. By the time these changes had been completed the packing season was at its height, and as there was more time and labor required than could then be devoted to remodeling the other boxes, the remodeled box was left as it stood, but the temperature was cut down to 200°. The cans had been cooking for only 75 minutes at 240° in the final heat, but after the change this was increased to 85 minutes for both boxes.

It is believed that a temperature of more than 210° with the top loose all around the rim, as in the clinching method used with sanitary cans, is dangerous, for the following reason. As the heat surrounding the thin shell of tin forming the can liberates the juices of the fish content the juices gravitate to the bottom and are drawn out to the sides, against which they cling by capillary attraction. The extraction of these juices is assisted by the salt with which the can has previously been charged, and as soon as the liquor reaches above the top of the flesh it will be found to stand at a slightly higher level all round the side of the can. Between this level and the lip of the can the distance is very short, and after this stage has been reached any rise of temperature to or above the boiling point will almost instantly affect the free liquor and by the combined action of ebullition and capillary attraction carry it out over the lip of the can. It seems quite evident that a sufficient vacuum may be secured without danger of loss in weight by a temperature of a

few degrees below the boiling point maintained for a slightly longer period of time than present practice prescribes.

Tops sometimes come off the sanitary cans inside the exhausters and cause no little trouble and delay. In at least two canneries limited numbers of cans were run through the boxes without tops by way of experiment. No mechanical trouble was developed, and the contents showed up well after coming out. There was no apparent loss of juice in either instance, and it should be noted that in neither was the temperature above 210°. One foreman reported that the surface of the exposed flesh seemed somewhat paler than normal, as if it might have been bleached out by the steam, while another claimed that he could observe no difference in color.

Heat units in salmon canning.—From a study of the methods used at a number of canneries, under the different systems considered here, a summary of the averages indicates that there is but little difference in the total number of heat units applied in the different processes. For purpose of comparison the arbitrary formula of degrees of heat (Fahrenheit scale) multiplied by the number of minutes at which this was maintained was adopted. Following is the tabulated summary:

Process.	Exhausting.		Cooking.		Total heat units.
	Minutes.	Temperature.	Minutes.	Temperature.	
Sanitary	11	208	93	241	24,700
Modified	16	204	86	240	23,900
Old style	40	220	60	240	23,200

In addition to the foregoing, it is the custom at all canneries, no matter what the system, to allow about five minutes at the beginning of the high temperature cook to work up the required heat of the retort, and when cooking is complete there is a like period for reducing the temperature and pressure before opening the doors.

Cans.—The form of can used and the methods of manipulating it, particularly as regards the manner of closing and the use of solder, are highly important phases of the canning industry. The paramount advantage of the sanitary over the other systems is undoubtedly in the superior type of can employed. While the sanitary system is comparatively new in the salmon packing industry, it has been employed by fruit and vegetable canners of this country for several years, and in Europe, particularly in Germany, its use is almost universal. The cans used in this system have already become popular with the consuming public; and by reason of the fact that the contents of such packages are commercially known and pushed forward as "sanitary," they are in stronger demand than are those of a similar sort packed in the old-style containers.

The sanitary can is readily distinguishable by the apparent absence of solder in the seams and the real absence of the one or two dots of solder which are to be found on one of the ends of the tins packed under other methods. As a matter of fact, the long side seam of the sanitary can is treated with both solder and flux, the latter usually of an acid character, but inasmuch as a properly made can will have no trace of either solder or flux on the inside, to all essential purposes it is a solderless and acidless container. The tops and bottoms are merely crimped on without acid or solder by machines called "double seamers," because they fold the flanges of side and end over twice in the crimping process.

The cans used in the old-style and modified systems are identical in character, solder and flux being used in side, top, and bottom seams. There is no difference whatever in the container before it is filled. They may be distinguished from each other by the solder dots which are to be found on one end of the can. A single dot in the center may denote a can which has been processed under the modified method, while two solder dots indicate the old-style process.

Most all of the sanitary cans used in southeast Alaska, and to a certain extent in the more remote sections of the Territory, are manufactured in the States and shipped empty to Alaska in the same cases in which, at the rate of 48 each, they are subsequently returned filled with salmon. The bulk of the empty cans thus makes the freight rates disproportionate with the weight involved. To reduce this item of expense, one of the large can companies has lately perfected plans and machinery to collapse the body of the can so that 400 may be packed in the ordinary 48 1-pound tall salmon case. Upon arrival at destination the collapsed bodies are run through a simple reshaping machine at the rate of about 70 per minute, and the bottoms may then be put on in the same manner as are the tops. It will be seen that in shipment the collapsed cans require only about one-sixth of the cubical space as compared with cans in the round at the rate of 48 to the case. One cannery man in southeast Alaska, figuring conservatively, says that using the collapsible cans on a 30,000-case pack he can effect a saving of $2,000 a season on the basis of present freight rates.

Another change which is being developed in the manufacture of sanitary cans is the use of a paper gasket to effectuate a tight joint, instead of the rubber-like compound generally used heretofore. The paper form is said to be a decided improvement.

Lacquering.—The amount of solder or acid left on the inside of the long body-seam of properly made old-style cans is so trifling as to be practically negligible, and the quantity which finds its way within through either of the end seams is equally insignificant, but the

fact that these agents are so used remains to prejudice the mind of the up-to-date consumer.

From the inception of the canning industry it has, with few exceptions, been the custom to coat all cans with some protecting medium; the reasons for this, as stated by Cobb,[a] are: (1) That the English market which, at the beginning especially, absorbed the greater part of these goods, insisted on their shipments being finished in this way, and (2) from the fact, as the canners speedily found out, that if they did not protect their cans in some way enormous losses through rust would ensue. The use of lacquer has been the means employed to afford the necessary protection. To secure good results in lacquering, however, it is necessary to have dry weather, a condition rarely assured in Alaska, particularly in the Bristol Bay region. Also there has always been the danger of fire owing to the highly inflammable character of commercial lacquering fluids. It is not surprising therefore, to find salmon packers largely adopting a compromise scheme whereby objectionable features in lacquering may be overcome. The plan is, briefly, to use only lacquered tops and bottoms, leaving the body to be protected by the label. The tops and bottoms can be purchased already lacquered.

Unfortunately, however, this does not entirely solve the problem. The thin film of varnish on the end piece has some hard knocks to withstand before the final casing of the can takes place, and a large percentage become marred and scratched. Where the ends of the can are the same, either entirely plain or bearing similarly stamped designs, this is not so serious a defect because it seldom happens that both ends of one can are defaced. But when an otherwise perfect can is badly marred on the end which is intended to be the top after the label has been put on, the matter becomes grave. A great deal depends upon the good appearance of a pack, and defaced tops in any quantity are a distinct defect.

As most of the scratches have been ascribed to the coolers in which the cans are cooked and handled on the cooking floor, a new type of cooler has been brought out. This has sides extending above the tops of the cans and cross braces in each corner, thus protecting the tops from contact with the bottom of any other cooler which may be placed above. The new coolers are undoubtedly a great improvement over the old type, but they have by no means entirely solved the problem.

The damp heat of exhausters and retorts may not be responsible for as many abrasions of varnished surfaces as some cannery men imagine, but that it does affect the lacquer to an extent to render it tender is the firm conviction of many. It is also believed that the softened varnish is further imperiled in the strong lye bath with which

[a] The salmon fisheries of the Pacific Coast, by John N. Cobb. Bureau of Fisheries Document No. 751.

it heretofore has been customary to treat the cans upon removal from the retorts. Part of the lye-bath treatment is the brisk scrubbing of the can tops with stiff brushes, and it has been conclusively demonstrated that under this action slightly scratched surfaces have been almost entirely denuded of their coat of lacquer. To avoid this as much as possible, some canners have adopted the plan of washing and spraying the cans both before entering and after leaving the exhaust boxes. The strong lye bath is then less necessary, and in fact has been eliminated to a considerable extent at quite a number of canneries. Instead, the cans are merely rinsed in a tank of warm water in which a small quantity—about a pound or two per day—of caustic soda has been dissolved. In spite of all these precautions, however, defaced cans continue to occur, which is further argument against the use of the prelacquered tops.

Another phase is that in the double-seaming process the thin coating of varnish is broken through entirely around the rim of the can, leaving it without protection from rust at a point where the metal, already strained by the bending and crimping to which it has been subjected, stands in need of greatest protection.

Labels, which are ordinarily attached by means of simple flour-and-water paste, afford only partial protection from rust. As a matter of fact, with the type of labeling machine commonly employed it is necessary to apply the paste rather freely, and the moisture thus coming in contact with an unlacquered or unprotected surface has been found to cause corrosion and pitting and in time will show through the label itself. Unlacquered fruit, vegetable, and milk cans subjected to the salt air and moist climate of coastal Alaska are found to rust under the paste of their labels, and the same is true to a greater or less extent of unlacquered salmon cans.

Whether the old plan of lacquering the entire can will be resumed is uncertain, yet many packers are paying constantly more and more attention to this feature of their work. A rusted can handed out by a retailer is open to the suspicion of being old and shopworn and an inferior article. It would seem very questionable, therefore, whether in the long run it will be deemed profitable to use the prelacquered end in Alaska as against the earlier plan of lacquering the entire can.

Do-overs.—The matter of do-overs is one that should receive most serious consideration at the hands of the cannery men. A few do-overs appearing in a well-established trade in salmon will work irreparable damage to the sales of a thoroughly wholesome and marketable product. Every do-over should be destroyed at the cannery.

The sanitary system of processing has produced a new type of do-over which in western Alaska is commonly referred to as a "slack"

can. This is one which has been insufficiently exhausted, necessitating another treatment, as follows: The cans are laid on their sides in the coolers with the long body seam uppermost. They are then retorted for from 20 to 30 minutes at a temperature ranging between 230° and 240° F., after which they are punctured at the edge of the solder streak of the body seam, blown, and quickly soldered. The contents of cans so treated are in all instances believed to be perfectly good, the package merely having lacked that amount of vacuum required by packing-house standards; this is supplied by the additional treatment.

While it is not fair to stigmatize this product with the odium attaching to the term "do-over," it is nevertheless not a first-grade commodity. The fact that the blow mark is placed on the side seam, where it may be thought a drop of solder formed when the can was made, and where it is certain to be covered later by a label which will conceal it from the view of the innocent consumer, shows that the packers themselves do not feel sure of it. Certainly they will not guarantee it, and just as certainly they will not try to market it in the British market. Like all second-grade goods, it is chiefly sold in blank to dealers who brand it with proprietary labels and distribute it chiefly in the American market.

Cannery Labor.

The question of securing competent or even fairly reliable help to perform the general inside work at the canneries in Alaska has in recent years grown to be one of the most vexatious problems with which cannery operators have had to contend. It would seem that with the introduction of various improved mechanical devices and the proportionately lessened number of employees required, conditions in this regard would now be better. But unfortunately such is not the case. Formerly most of the labor was performed by Chinese, who were reliable and competent for every class of inside cannery work; but now it is very difficult to obtain Chinese labor, and the result has been a miscellaneous collection of Mexicans and Japanese, Filipinos and other Orientals, who are not as tractable and dependable as the Chinese.

The importation of cannery labor is essential, as Alaska can not begin to supply the demand. With the exception of those in the Afognak and Kodiak regions and a few other places, the native Indians of central and western Alaska are as a rule unreliable as cannery hands; moreover, their numbers are pitifully few. In southeast Alaska several thousand natives, including men, women, and children, are given employment at the canneries, and they do quite well. Nevertheless, the fact remains that it is necessary to

import help to take care of the salmon harvest, and since there are but relatively few Chinese now available, the natural result is the heterogenous Oriental element above named. In consequence of this, constant vigilance must be exercised by the cannery operators to keep things going properly. But even the exercise of every precaution is not sufficient, for occasionally there are labor troubles that mean heavy loss to the salmon packer.

It therefore becomes a matter of no little interest to note the manner whereby the management of the Taku Canning & Cold Storage Co. in southeast Alaska bettered the situation this season in such successful fashion that an expansion of the idea may do much toward solving a most vexatious problem.

Rather early in the season, 18 Japanese who had contracted to work at the Taku cannery throughout the season ignored their agreement, and left under the pretext that they were afraid the organization was not sufficiently solvent to pay them off should they remain. That this was merely a subterfuge is evidenced by the fact that a properly secured bond was no inducement for them to continue work. Badly in need of help to recruit his much-crippled force, and with no adequate local labor resources, Manager J. L. Carlson decided to inaugurate the plan of importing white girls experienced in cannery work in the States. Accordingly a few days later 10 girls arrived from Astoria, Oreg., and were employed throughout the season. They were more rapid and efficient workers than the Oriental and Indian labor previously engaged, and were fully competent to perform the various duties about the lines of machinery, as well as lacquering and labeling, also hand filling the flat cans. Particularly in the latter were they preferable to the native Indian women, both by reason of their efficiency and neatness. Separate quarters and mess arrangements were provided. The success of the undertaking was so pronounced that the idea might with profit be applied at other canneries.

Disasters and Losses in the Salmon Industry.

Relatively speaking, losses either in the way of life or of property in the salmon industry have been remarkably light this season. So far as reported, the only accidental loss of life was the drowning of three fishermen on Nushagak Bay.

On July 7, while opposite Funter Bay, the cannery tender *Jack Horner*, operated by the Pacific American Fisheries at Excursion Inlet, took fire as a result of the engine's back-firing. The 10 men aboard at the time were transferred to the tender *Concord*, which fortunately happened to be nearby. The *Jack Horner* was taken in tow, and was finally beached at Point Howard. Though the vessel was destroyed, it is noteworthy that the fuel tanks did not explode;

only the water tank in the engine room burst. This was one of the largest and best-equipped cannery tenders in southeast Alaska. It was 72 feet in length, of 50 tons gross register, and was built at Seattle in 1911.

While enroute from Cook Inlet to Puget Sound, the steam cannery tender *Kayak*, belonging to the Seldovia Salmon Co. struck at Point Carrew, near Yakutat, on the night of August 26, and became a total loss. On account of a severe gale, an effort was being made to get into Yakutat Harbor, but the channel was missed and the disaster followed. The 10 men comprising the crew took to the boats, and after a trying experience finally got ashore. The *Kayak* was built at Alameda in 1901, was 91 feet in length, and registered 115 tons, gross.

The power cannery tender *Kake*, belonging to the Kake Packing Co., was wrecked November 1 on Clatsop Spit, at the mouth of the Columbia River. The vessel left Kake, Alaska, October 14 with the intention of proceeding to Astoria, Oreg., for the winter. The 60 cases of half-pound cohos, and 258 cases of 1-pound tall chums, carried as ballast, may be considered as a total loss, although some 38 cases were picked up on the beach in a badly damaged condition. The wreck of the vessel was sold by the underwriters for a small sum.

When the steamer *State of California* was wrecked in Gambier Bay on August 17 the Alaska Sanitary Packing Co., of Wrangell, sustained a loss of 650 cases of salmon, all pinks.

During a gale on May 15, the cannery ships *Tacoma*, of the Alaska Packers Association, and *St. Nicholas*, of the Columbia River Packers Association, went ashore on the flats at the west entrance to Nushagak estuary, between Protection Point and the mouth of the Igushik River. Both vessels were floated later, having suffered no serious damage. About the same time the ship *Standard*, of the North Alaska Salmon Co., went ashore near Cape Constantine, and was badly pounded before working off.

During a blow on May 28, about 19,000 cases of tin plate were lost overboard from a lighter alongside one of the Alaska Packers Association ships in the Naknek roadstead. On account of this accident, it became necessary to have a steamer make the long run to Larsens Bay and return to replenish the supply of tin.

Canneries Operated.

During 1913 there were 42 canneries in operation in southeast Alaska, 9 less than in 1912; 14 in central Alaska, the same as 1912, while in Western Alaska this season there were 23 canneries in operation, a gain of 1 over the previous year. Thus the totals are 87 for 1912 and 79 for 1913.

Companies Canning Salmon in Alaska, Number and Location of Canneries Operated, and Number of Traps Owned by Each.

Names.	Canneries.	Location.	Traps.
Southeast Alaska:			
Admiralty Trading Co	1	Gambier Bay	4
Alaska Fish Co	1	Waterfall	1
Alaska Pacific Fisheries	3	Chilkoot Inlet	a 6
		Yes Bay	b 7
		Chomley	b 5
Alaska Packers Association	2	Loring	c 7
		Wrangell	d 4
Alaska Sanitary Packing Co	1	Wrangell	
Astoria & Puget Sound Canning Co	1	Excursion Inlet	4
F. C. Barnes Co	1	Lake Bay	5
Deep Sea Salmon Co	1	Ford Arm	2
Fidalgo Island Packing Co	1	Ketchikan	3
Hawk Fish Co	1	Hawk Inlet	4
Hidden Inlet Canning Co	1	Hidden Inlet	
Hoonah Packing Co	1	Hoonah	6
Irving Packing Co	1	Karheen	3
Kake Packing Co	1	Kake	4
The Kasaan Co	1	Kasaan	2
Kuiu Island Packing Co	1	Beauclaire	
Lindenberger Packing Co	2	Roe Point	e 3
		Craig	3
George T. Myers & Co	1	Chatham	4
North Pacific Trading & Packing Co	1	Klawak	
Northwestern Fisheries Co	4	Hunter Bay	b 1
		Quadra	1
		Santa Ana	b 1
		Dundas Bay	3
Pacific American Fisheries	1	Excursion Inlet	15
Pacific Coast & Norway Packing Co	1	Petersburg	4
Pillar Bay Packing Co	1	Pillar Bay	2
Pure Food Fish Co	1	Ketchikan	
Sanborn-Cram Co	1	Burnett Inlet	b 4
Shakan Salmon Co	1	Shakan	1
Skowl Arm Packing Co	1	Skowl Arm	
Starr-Collinson Packing Co	1	Moira Sound	b 1
Sunny Point Packing Co	1	Chomley	
Taku Canning & Cold Storage Co	1	Taku Harbor	a 8
Tee Harbor Packing Co	1	Tee Harbor	6
Thlinket Packing Co	1	Funter Bay	13
Walsh-Moore Canning Co	1	Ward Cove	
Wiese Packing Co	1	Rose Inlet	
Yakutat & Southern Ry. Co	1	Yakutat	
Central Alaska:			
Alaska Packers Association	4	Kasilof	18
		Larsen Bay	
		Alitak	
		Chignik	13
Columbia River Packers Association	1	Chignik	13
Fidalgo Island Packing Co	1	Port Graham	2
Kadiak Fisheries Co	1	Kodiak	
Libby, McNeill & Libby	1	Kenai	11
Northwestern Fisheries Co	4	Orca	
		Kenai	10
		Uyak	
		Chignik	11
Pacific American Fisheries	1	King Cove	3
Seldovia Salmon Co	1	Seldovia	3
Western Alaska:			
Alaska Fishermen's Packing Co	2	Nushagak Bay	
		Kvichak Bay	
Alaska Packers Association	8	Nushagak Bay (2)	5
		Kvichak River (2)	1
		Naknek River (3)	
		Ugaguk River	
Alaska-Portland Packers Association	1	Nushagak Bay	3
Alaska Salmon Co	1	Wood River	
Bristol Bay Packing Co	1	Kvichak Bay	
Columbia River Packers Association	1	Nushagak Bay	
Midnight Sun Packing Co	1	Kotzebue Sound	2
Naknek Packing Co	1	Naknek River	
North Alaska Salmon Co	4	Nushagak Bay	
		Kvichak River (2)	1
		Ugaguk River	
Northwestern Fisheries Co	1	Nushagak Bay	
Pacific American Fisheries	1	Port Moller	1
Red Salmon Canning Co	1	Ugashik River	

a 2 floating. b All floating. c 6 floating. d 3 floating. e 2 floating.

The foregoing list does not show independent traps selling fish to canneries.

Canneries not Operating in 1913.

Nine of the canneries in southeast Alaska were not operated this year, as follows:

	Location of plant.
Point Ward Packing Co.	Point Ward.
Canoe Pass Packing Co.	Canoe Pass.
Herbert Hume Packing Co.	Nakat Harbor.
Metlakahtla Industrial Co.	Metlakahtla.
Revilla Fish Products Co.	Ketchikan.
Swift, Arthur-Crosby Co.[a]	Heceta Island.
St. Elias Packing Co.	Dry Bay.
Alaska Fish Co.	Ship *Glory of the Seas.*
Weiding & Independent Fisheries	Ship *William H. Smith.*

With the exception of the Metlakahtla Industrial Co., the St. Elias Packing Co., and the Alaska Fish Co., all of the foregoing plants were first operated as canneries in 1912.

The Salmon Catch and Forms of Gear.

In the southeast Alaska salmon canning industry there were in operation 127 stationary and 36 floating traps, a total of 163 traps; in central Alaska there were 84 traps in the canning industry, 2 in mild-cure work, and 1 in pickling operations, a total of 87 traps, all stationary; and in western Alaska there were 13 traps devoted to the canning industry and 4 to pickling, a total of 17 traps, all stationary. Assembling the foregoing figures, there is a total of 231 stationary and 36 floating traps, or a grand total of 267 traps throughout Alaska for the year 1913. During 1912 there were 273 traps devoted to canning and 5 to pickling, of which 242 were stationary and 36 floating. Thus there were 11 less traps in operation in 1913 than in 1912. The falling off occurred in southeast Alaska. Fewer canneries were in operation in 1913, and while some companies put in traps for the first time this year, other companies lessened their number.

In all of the branches of the salmon industry there was a total of 238 purse and drag seines operated in Alaska in 1913 as compared with 474 the previous year. The falling off was due to the absence of the fleet of Puget Sound purse seiners, which invaded southeast Alaska in 1912, and also to the fact that fewer canneries were operated. In the matter of gill nets, the figures for 1913 show 2,470 as compared with 2,240 the year before. The gain was chiefly in mild-cure operations.

[a] Mild-cure operations in 1913.

SALMON TAKEN IN 1913, BY SPECIES AND APPARATUS, FOR EACH GEOGRAPHIC SECTION OF ALASKA.

Apparatus and species.	Southeast Alaska.	Central Alaska.	Western Alaska.	Total.
Seines:	*Number.*	*Number.*	*Number.*	*Number.*
Coho, or silver	168,430	28,466	17	196,913
Dog, or chum	1,543,682	6,868	1,964	1,552,514
Humpback, or pink	12,382,921	1,013,714	.....	13,396,635
King, or spring	963	1,534	142	2,639
Red, or sockeye	779,877	1,835,283	523,805	3,138,965
Total	14,875,873	2,885,865	525,928	18,287,666
Gill nets:				
Coho, or silver	116,251	2,365	80,935	199,551
Dog, or chum	12,193	3,159	272,993	288,345
Humpback, or pink	16,317	5,102	192,022	213,441
King, or spring	47,271	22,369	75,088	144,728
Red, or sockeye	347,000	414,512	20,341,920	21,103,432
Total	539,032	447,507	20,962,958	21,949,497
Traps:				
Coho, or silver	291,731	102,914	7,090	401,735
Dog, or chum	973,962	42,780	67,700	1,084,442
Humpback, or pink	13,101,582	101,403	190,000	13,392,985
King, or spring	18,289	45,947	3,842	68,078
Red, or sockeye	1,119,081	2,548,701	604,917	4,272,699
Total	15,504,645	2,841,745	873,549	19,219,939
Lines:				
Coho, or silver	42,601	.....	.....	42,601
King, or spring	327,675	.....	.....	327,675
Total	370,276	.....	.....	370,276
Dip nets: Red, or sockeye	.....	86,200	.....	86,200
Spears: Humpback, or pink	.....	1,550	.....	1,550
Total:				
Coho, or silver	619,013	133,475	88,042	840,800
Dog, or chum	2,529,837	52,807	342,657	2,925,301
Humpback, or pink	25,500,820	1,121,769	382,022	27,004,611
King, or spring	394,198	69,850	79,072	543,120
Red, or sockeye	2,245,958	4,884,696	21,470,642	28,601,296
Grand total	31,289,826	6,262,867	22,362,435	59,915,128

Figures for the proportion of catch by the principal forms of gear show that in southeast Alaska the total catch by seines dropped from 50 per cent in 1912 to 48 per cent in 1913, while the trap catch increased from 47 per cent in 1912 to 50 per cent in 1913. In central Alaska, however, the reverse occurred, for the seine catch increased from 40 to 47 per cent, while the trap catch decreased from 50 per cent in 1912 to 46 per cent in 1913. In western Alaska seines were used for the first time this year, except in an experimental way, and the catch thus made was about 2 per cent of the total. The catch by traps dropped from 6 per cent to 4 per cent this year, and the gill net catch increased from 93 to 94 per cent.

PERCENTAGE OF TOTAL CATCH OF SALMON BY THREE PRINCIPAL FORMS OF GEAR.

Apparatus.	Southeast Alaska.		Central Alaska.		Western Alaska.	
	1912	1913	1912	1913	1912	1913
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Seines	50	48	40	47	.....	2
Traps	47	50	50	46	6	4
Gill nets	2	2	9	7	93	94

Considering Alaska as a whole, 30 per cent of the salmon caught in 1913 were taken by seines, 32 per cent in traps, and 36 per cent by means of gill nets. The year before, seines took 31 per cent, traps 33 per cent, and gill nets 34 per cent. Thus, for all Alaska, 1913 shows as to proportion of catch a gain of 1 per cent for seines, a loss of 1 per cent for traps, and a gain of 2 per cent for gill nets.

The total catch of salmon in 1913 was 59,915,128 as against 60,938,945 in 1912, a decrease of 1,023,817. The number of reds was about the same this year; kings gained 66,000; pinks gained approximately 2,970,000; cohos fell off 620,000; and chums declined 3,433,000 in number this year.

Statistics.

The number of canneries in operation in Alaska during 1913 was 79 as compared with 87 for 1912. The total investment declined from $33,759,295 in 1912 to $31,341,670 for 1913. The decrease was chiefly in southeast Alaska.

The number of persons employed in 1912 was 17,705 and 16,513 in 1913, a decrease of 1,192 persons, also almost wholly in the southeast section. Although there was a decrease of about 7 per cent this year, it is interesting to note that both the numbers of whites and natives show slight gains. This condition should inure to the benefit of Alaska. Of the Oriental element, Japanese and Filipinos are supplanting the declining numbers of Chinese.

In 1912 the pack of canned salmon was 4,054,641 cases, valued at $16,291,927, while in 1913 it was 3,739,185 cases, valued at $13,531,604, a decrease of 315,456 cases and $2,760,323 in value. By sections the case pack comparison is as follows: Southeast Alaska declined from 2,033,648 to 1,782,898 cases, a difference of 250,750 cases; central Alaska dropped from 625,062 to 447,249 cases, a loss of 177,813 cases; but in western Alaska there was an increase from 1,395,931 cases in 1912 to 1,509,038 cases in 1913, a gain of 113,107 cases. Comparisons by species show the following: The pack of cohos declined from 166,198 to 75,779 cases, a loss of 90,419 cases; chums dropped from 664,633 to 290,918, a loss of 373,715 cases; and kings went from 43,317 down to 34,370, a decline of 8,947 cases; but pinks increased from 1,280,138 to 1,372,881, a gain of 92,743 cases; and reds also gained from 1,900,355 to 1,965,237, an increase of 64,882 cases. The net decrease, however, for 1913 was 315,456 cases, due chiefly to the lighter pack of chums.

Investment in the Salmon-Canning Industry in 1913.

Items.	Southeast Alaska.		Central Alaska.		Western Alaska.		Total.	
	No.	*Value.*	*No.*	*Value.*	*No.*	*Value.*	*No.*	*Value.*
Canneries	42	$3,946,518	14	$1,416,880	23	$3,136,351	79	$8,499,749
Working capital	.....	4,298,930	.....	2,147,600	.....	5,374,900	.....	11,821,430
Wages paid	.....	1,946,736	.....	893,250	.....	2,516,956	.....	5,356,942
Vessels:								
Power vessels over 5 tons	111	611,149	44	471,740	55	924,120	210	2,007,009
Net tonnage	2,118	.....	1,790	.....	4,822	.....	8,730	.....
Launches under 5 tons	39	47,860	16	20,527	18	27,851	73	96,238
Sailing	8	214,000	11	412,236	34	864,032	53	1,491,168
Net tonnage	10,131	.....	19,844	.....	41,856	.....	77,831	.....
Boats, sail and row	636	45,241	442	41,832	1,056	207,688	2,134	294,761
Lighters	242	121,112	188	119,666	145	163,852	575	404,630
Pile drivers	38	124,363	31	86,316	19	41,375	88	252,054
Apparatus:								
Haul seines	60	14,200	47	17,385	.....	.....	107	31,585
Fathoms	7,419	.....	11,449	.....	.....	.....	18,868	.....
Purse seines	184	81,767	6	4,221	6	4,164	196	90,152
Fathoms	33,432	.....	1,130	.....	1,440	.....	36,002	.....
Gill nets	257	30,477	183	17,064	1,624	192,883	2,064	240,424
Fathoms	62,175	.....	19,495	.....	234,981	.....	316,651	.....
Traps, driven	127	372,039	84	271,538	13	19,369	224	662,946
Traps, floating	36	92,553	.....	.....	.....	.....	36	92,553
Dip nets	18	29	.....	.....	.....	.....	18	29
Total	.....	11,946,974	.....	5,920,255	.....	13,474,441	.....	31,341,670

Persons Engaged in the Salmon-Canning Industry in 1913.

Occupations and races.	Southeast Alaska.	Central Alaska.	Western Alaska.	Total.
Fishermen:				
Whites	584	752	2,027	3,363
Indians	1,157	220	45	1,422
Japanese	2	.....	.....	2
Miscellaneous[a]	2	.....	.....	2
Total	1,745	972	2,072	4,789
Shoresmen:				
Whites	1,157	474	1,520	3,151
Indians	1,431	265	475	2,171
Chinese	865	328	857	2,050
Japanese	787	252	571	1,610
Miscellaneous[a]	336	316	1,257	1,909
Total	4,576	1,635	4,680	10,891
Transporters:				
Whites	293	171	360	824
Indians	2	6	1	9
Total	295	177	361	833
Grand total:				
Whites	2,034	1,397	3,907	7,338
Indians	2,590	491	521	3,602
Chinese	865	328	857	2,050
Japanese	789	252	571	1,612
Miscellaneous[a]	338	316	1,257	1,911
Total	6,616	2,784	7,113	16,513

[a] Filipinos, Mexicans, negroes, Porto Ricans, etc., are included under the miscellaneous heads.

Output of Canned Salmon in 1913, by Species and Size of Cases.[a]

Products.	Southeast Alaska.		Central Alaska.		Western Alaska.		Total.	
	Cases.	*Value.*	*Cases.*	*Value.*	*Cases.*	*Value.*	*Cases.*	*Value.*
Coho, or silver:								
½-pound flat	3,587	$20,038	.....	.....	.....	.....	3,587	$20,038
1-pound flat	266	1,058	.....	.....	.....	.....	266	1,058
1-pound tall	52,643	175,750	13,244	$44,582	6,039	$20,226	71,926	240,558
Total	56,496	196,846	13,244	44,582	6,039	20,226	75,779	261,654
Dog, or chum:								
½-pound flat	985	2,968	.....	.....	.....	.....	985	2,968
1-pound flat	2,619	7,333	.....	.....	.....	.....	2,619	7,333
1-pound tall	254,040	553,053	5,038	11,118	28,236	69,476	287,314	633,647
Total	257,644	563,354	5,038	11,118	28,236	69,476	290,918	643,948
Humpback, or pink:								
½-pound flat	20,822	87,198	.....	.....	.....	.....	20,822	87,198
1-pound flat	3,258	9,375	.....	.....	.....	.....	2,258	9,375
1-pound tall	1,265,657	3,241,633	49,309	126,360	33,835	86,021	1,348,801	3,454,014
Total	1,289,737	3,338,206	49,309	126,360	33,835	86,021	1,372,881	3,550,587
King, or spring:								
½-pound flat	369	2,701	.....	.....	1,216	7,786	1,585	10,487
1-pound tall	841	2,698	15,393	61,882	16,551	63,986	32,785	128,566
Total	1,210	5,399	15,393	61,882	17,767	71,772	34,370	139,053
Red, or sockeye:								
½-pound flat	19,936	150,467	4,957	33,401	4,148	36,014	29,041	219,882
1-pound flat	11,735	63,034	.....	.....	.....	.....	11,735	63,034
1-pound tall	146,140	668,256	359,308	1,638,311	1,419,013	6,346,879	1,924,461	8,653,446
Total	177,811	881,757	364,265	1,671,712	1,423,161	6,382,893	1,965,237	8,936,362
Grand total	1,782,898	4,985,562	447,249	1,915,654	1,509,038	6,630,388	3,739,185	13,531,604

[a] Half-pound cases contain 48 ½-pound cans, but for convenience in comparing with the 1-pound cases, which contain 48 cans, they have been reduced one-half in number, thus equaling in weight the 1-pound cases.

Output of Canned Salmon, 1907–1913.[a]

Products.	1907	1908	1909	1910	1911	1912	1913	Total.
Coho, or silver:	*Cases.*	*Cases.*	*Cases.*	*Cases.*	*Cases.*	*Cases.*	*Cases.*	*Cases.*
½-pound flat	485	105	.....	163	1,574	2,719	3,587	8,633
1-pound flat	3,933	2,414	1,206	2,249	1,075	17	266	11,160
1-pound tall	80,772	66,309	55,350	111,614	131,259	163,462	71,926	680,692
Total	85,190	68,828	56,556	114,026	133,908	166,198	75,779	700,485
Dog, or chum:								
½-pound flat	246	.....	.....	.....	.....	2,795	985	4,026
1-pound flat	664	107	.....	.....	7,245	.....	2,619	10,635
1-pound tall	183,262	218,406	120,712	254,218	316,550	661,838	287,314	2,042,300
Total	184,172	218,513	120,712	254,218	323,795	664,633	290,918	2,056,961
Humpback, or pink:								
½-pound flat	8,795	.....	.....	3,188	4,836	13,712	20,822	51,353
1-pound flat	7,406	569	.....	7,900	9,437	.....	3,258	28,570
1-pound tall	545,772	643,564	464,873	543,233	991,005	1,266,426	1,348,801	5,803,674
Total	561,973	644,133	464,873	554,321	1,005,278	1,280,138	1,372,881	5,883,597
King, or spring:								
½-pound flat	14	62	.....	54	67	5,151	1,585	6,933
1 pound tall	43,410	23,667	48,034	40,167	45,451	38,166	32,785	271,680
Total	43,424	23,729	48,034	40,221	45,518	43,317	34,370	278,613
Red, or sockeye:								
½-pound flat	22,692	10,909	8,193	22,320	13,601	28,024	29,041	134,780
1-pound flat	29,821	26,950	85,193	39,941	4,967	16,242	11,735	214,849
1-pound tall	1,242,600	1,613,911	1,611,916	1,388,006	1,296,750	1,856,089	1,924,461	10,933,733
Total	1,295,113	1,651,770	1,705,302	1,450,267	1,315,318	1,900,355	1,965,237	11,283,362
Grand total	2,169,872	2,606,973	2,395,477	2,413,053	2,823,817	4,054,641	3,739,185	20,203,018

[a] The ½-pound cans have been reduced one-half in number and treated as 1-pound cans.

AVERAGE ANNUAL PRICE PER CASE OF 48 1-POUND TALL CANS OF SALMON, 1905–1913.

Product.	1905	1906	1907	1908	1909	1910	1911	1912	1913
Coho, or silver	$3.20	$3.63	$3.91	$3.98	$4.07	$4.89	$5.67	$4.44	$3.45
Dog, or chum	2.69	2.87	2.97	2.53	2.28	3.04	3.72	2.37	2.21
Humpback, or pink	2.95	3.00	3.16	2.69	2.40	3.15	3.94	2.55	2.58
King, or spring	3.28	3.78	4.18	4.20	4.32	5.34	6.48	5.37	4.04
Red, or sockeye	3.38	3.77	4.59	4.52	4.53	5.30	6.33	5.45	4.54

MILD CURING.

EXTENT AND METHODS.

In the salmon fisheries of Alaska, the process of mild curing takes rank second only to that of canning. As a result of the successful season in mild-cure operation during 1912, an unusual interest in this field was exhibited during the spring and early summer of 1913. Various new stations were built, and a greatly increased fleet of both power boats and hand trollers began operations in April.

As was the case last season, the Forrester Island grounds proved very attractive. This island is in a Federal bird reserve and is under the control of the Department of Agriculture. New regulations were promulgated by that Department in respect to fishing privileges within the reserved waters about the island, and Game Warden Cooper was stationed there to enforce the regulations. Also Dr. Harold Heath, of Stanford University, spent most of the season on the island making a study of its birds, fishes, and mammals.

The additional restrictions imposed this year as to fishing operations about Forrester Island limited the total number of power-boat permits in effect at one time to 25. Also no permits were issued for any boat not conforming absolutely with the navigational requirements of the Department of Commerce. And, in addition, no permit was to be continued in force in the case of a person not abiding by the rules of the fishing camp. Permits were also denied aliens who desired to fish near the island.

A total of 398 rowboat permits were issued, though the highest number in force at one time was 341. All told, 34 power-boat licenses were granted. A number of power boats defied the authority of the warden and fished in the restricted area without permission, disappearing before they could be apprehended. Another year an additional officer ought to be stationed at the island, and a seaworthy power boat should be provided for his use. This season several permits were revoked for various causes, and the former holders were forced to leave the island.

No lives were lost this season, though there were a number of narrow escapes. Several of the small boats were dashed to pieces upon the rocks or were carried away during heavy blows. On account of the exposed position of Forrester Island, and the heavy

weather frequently experienced, it is not possible to fish more than four days a week on the average. A fund of about $600 was collected from the fishermen to construct a runway to facilitate the landing of the small boats. Prior to this many had been badly pounded on the rocky shore as they landed in the swell or through the surf.

Operations began May 3 and officially came to a close August 12, though a few hand boats remained several days longer. The low price obtained for mild-cured salmon shortened the season.

The best day's catch reported by any one hand troller was 52 king salmon, while the high boat for the season caught fish to the value of $650. The most successful power trolling boat caught $1,150 worth of salmon thoughout the season. The price paid the fishermen was $1 for red-meated and 30 cents each for white-meated fish. Five companies engaged in buying fish at the island; the fish were taken by run vessels to the shore stations on Prince of Wales and Dall Islands.

Various fishing camps were established this season at the newly developed trolling grounds north of Forrester Island, in the vicinity of Noyes, San Lorenzo, San Pedro, Anguilla, Baker, and other islands of the region. Also the older grounds on the inside reaches at Cape Fanshaw, Union Bay, Cape Camaano, Point Baker, and other places were fished extensively. But aside from the Forrester Island operations, the greatest activity in king salmon troll fishing centered at Port Conclusion and at Port Alexander, a few miles above Cape Ommaney. This is the first season that operations have been conducted here on an extensive scale. The development of this region is in line with the tendency of the last two seasons or so to get nearer to the sea to anticipate the incoming run of salmon.

Fishing operations began about April 15, and, aside from a few boats, the season ended the middle of July. The best catches were made during the latter half of May and through the month of June. There is also a fall season along in September and October, but the low price did not warrant fall fishing this season. The constant tendency of king salmon trollers to shift from place to place makes it difficult to get exact figures as to the number of boats operating. The best estimates for the Cape Ommaney region, however, are 300 power boats of all sizes and descriptions, and 400 hand trolling boats. So numerous were the fishermen that not infrequently salmon were snagged as the boats moved back and forth. As a matter of fact, the field was overworked, and but few had a profitable season.

The power trollers fish more with spoons than bait, hence nearer the surface. The result is that they take more small fish than do the hand boat trollers, who use herring for bait more frequently and catch most of their fish 10 or 12 fathoms below the surface. There is no definite rule in the form of lure, as some days spoons

appear to be preferable while at other times bait does better. In taking a hook, it is said that the salmon do not strike directly from the rear as the lure moves slowly through the water, but instead they circle and take it head on as it moves toward them. Fishermen think that this supposed tendency results in the considerable number of snagged fish for which the power trollers are responsible. As a matter of fact, it is difficult to slow down the power boats as much as should be, and for this reason they are apt to snag fish. A speed of 2 miles an hour is fast enough. Drags are sometimes used to reduce speed.

Undoubtedly as a proper means of catching king salmon the power boat is less desirable than the hand trolling boat. In the case of the latter practically every fish hooked is landed, instead of the many that are torn from the hooks of the power-boat fishermen. Some of the larger power boats had as many as 10 lines out at one time—2 from the mast, 4 from outriggers, and 2 each from 2 skiffs towed behind.

The fishing gear for trolling usually consists of an Ewell-Stewart no. 7 spoon, with either a no. 10 or no. 11 hook. Above the spoon and swivel is a twisted wire snell about 3 feet long, and above this is placed the lead sinker. Ordinarily 100 feet of line is used. The favorite size is 48-thread hard-laid tanned line. Sinkers varying in weight from 1 to 7 pounds are used by the hand trollers, while sometimes the power boats use weights of as much as 12 or 15 pounds. As a rule the power boats do not fish with heavy enough sinkers, and this also applies in a measure to hand trollers. Tests show that the larger fish are caught 10 or 12 fathoms below the surface. They were notably small this year, the average in the Cape Ommaney region being approximately 17 pounds as taken from the water. One salmon weighing 66 pounds was noted, but many were taken weighing only 5 or 6 pounds, or even less.

Most of the buyers paid the fishermen $1 each for red meated kings and 30 cents for white meated, regardless of size. On the Taku the fishermen received 4½ cents a pound for red meated and 1½ cents a pound for white meated kings. One company in the Cape Ommaney region paid 4 cents a pound for reds and 30 cents each for whites; another concern part of the time paid 5 cents a pound for reds and 2 cents a pound for whites. Where the fishermen took out tierces and salt and packed the fish themselves, the prevailing price was 11 cents a pound for fletches weighing 8 pounds each or more; 7 cents a pound for the medium-sized sides of 6 to 8 pounds; and 3 cents a pound for the sides running under 6 pounds each. Fish caught by the hand trollers were regarded more highly by the buyers than those taken by the power boats. A better price was sometimes paid to the hand trollers.

There was a good run of kings in the Taku this year; also the traps in Icy Strait caught quite a few kings the early part of June. For a first-class mild-cure product it is necessary to handle the fish gently at all times. This rule was not observed faithfully in the case of some of the trap fish, and the result was that the sides or fletches showed broken or ruptured spots in the tissues of the flesh. The gill-net fish from the Taku did not show these ruptures. The red-meated kings from the Taku were mild-cured, while most of the white-meated kind were frozen. It is said by some that king salmon from the Taku command a better price in the German markets, to which much of the mild-cured product goes, as they seem to have a brighter appearance than those from other places. In the Taku region the percentage of whites is higher some seasons than others, but on the average it is about 15 per cent. The records of one company show that for a period of two weeks in 1910 nearly 48 per cent of the king salmon received were white-meated. Taking a fair average of southeast Alaska as a whole, the catch of white-meated kings runs about 18 per cent. The catch of whites is heaviest during the early part of the season.

In the general method of mild-curing king salmon at the shore stations, the fish are placed on a table with the heads projecting over the edge. One man then cuts off the heads and the fish are scored four or five times on each side so as to permit of better curing. The next step is the removal of the viscera, following which a longitudinal cut is made just above the backbone the entire length of the body, and a similar cut is made just below the backbone. This divides the fish into two sides or fletches, and the backbone and tail are thrown away. In order to command the best price it is necessary to have each side weigh 8 pounds or upwards. The medium grade as to size runs from 6 to 8 pounds, while the smalls are under 6 pounds. For each 800-pound tierce it takes on the average 70 sides or fletches of the larger size. In the case of the mediums the average is 120 sides per tierce, while the smalls run about 180 sides. Sometimes when the fish run extra small they are opened up but not split into two sides. The fletches are placed carefully in the tierces in layers of salt, and after being headed up, the tierces are turned on their sides, which causes the fletches to be on edge and thus allows the brine to get in more effectively between them. After about 12 days the tierces are opened and the fletches are sorted and repacked in fresh brine, ready for shipment. They must at all times be kept in a cool temperature.

It not infrequently happens that the so-called mild-cured king salmon of Alaska is in reality more of a hard-pickled product. On the Columbia River, where salting is light and the fish are kept at a temperature of about 35 degrees, a truly mild-cured product is the

result, but in Alaska where tierces and salt are taken out by fishermen who have little knowledge of the process and have no cooling facilities, it is necessary to use about one-third more salt, and the resultant product almost passes from the mild-cure classification. This, of course, does not apply to the shore stations where fish are delivered in the round and are so packed as to insure a high-grade mild-cured product. The heavier production this season, together with the poorer quality of the rather carelessly prepared power-boat pack, resulted in so lowering the price that, taken as a whole, returns have not been satisfactory. Also, in this connection it must be noted that the cost of production was greater this year, since most of the fish were purchased at the flat rate of $1 each, irrespective of size, and it so happened that the average weight was considerably lower than in the past. Instead of the usual average of about 45 fish to a tierce, this season's general averages show that it took approximately 55 king salmon to fill a tierce.

Principal mild-cure plants.—With four plants in operation, Engelbr. Wiese (Inc.) was engaged more extensively in the mild-cure business than any other concern in Alaska this season. The station at Ketchikan was operated the same as last year, but the plant at Howkan was superseded by a new establishment at Waterfall on the west coast of Prince of Wales Island, which location is more convenient to the fishing grounds. This is a large plant with suitable cold-storage machinery and storage capacity for about 300 tierces. The Wiese company also built a new mild-cure station this season at Port Conclusion, a few miles north of the king salmon trolling ground about Cape Ommaney. A 2½-ton ice-plant and storage facilities for 200 tierces were provided. The fourth Wiese plant was at Hoonah, where a new building erected for the purpose was leased from the Hoonah Packing Co. King salmon from the Icy Strait traps were mild cured at this establishment.

Another concern operating extensively in the mild-cure field in Alaska was the Vendsyssal Packing Co., with headquarters at the former whaling station at Tyee. This company also engaged in mild-cure work at Sitka. The Columbia & Northern Fishing & Packing Co. engaged heavily in mild-cure operations, and in addition to the main plant at Wrangell a floating receiving station was utilized at Port Alexander near the lower end of Baranof Island, where fish were received for transfer to Wrangell. The Pacific Coast & Norway Packing Co. had a mild-cure station at Cape Fanshaw. Cold-room facilities for 200 tierces were provided. Ice from a near-by glacier was used for cooling purposes. Still another extensive operator in the mild-cure business was J. Lindenberger (Inc.), at Craig. Ample cold-storage and freezing facilities were afforded at this plant.

A new mild-cure station was built and operated in conjunction with the cannery of the North Pacific Trading & Packing Co. at Klawak. The facilities include cold-room capacity for 250 tierces and a 2-ton ice machine. The cannery operated last year at Warm Chuck by Swift, Arthur & Co., was used this year as a mild-cure station. The company was reorganized under the name of the Swift-Arthur-Crosby Co. (Inc.). A 2½-ton ice machine was put in, together with a refrigerating room of 250 tierces capacity.

Other more important operators in mild-cure work in southeast Alaska this season included the Diamond T Packing Co., of Ketchikan, with also a floating auxiliary plant at Dall Island, and the Taku Canning & Cold Storage Co., at Taku Harbor. The Sanborn-Cram Co. at Burnett Inlet also put up mild-cure salmon before the canning season opened, and the Kake Packing Co. was likewise engaged at Kake. M. E. Lane put up mild-cure salmon at Union Bay, as did also Gottfried Friedrichs at Wrangell. M. B. Dahl had a floating plant at Karheen and Port Alexander, and S. B. Reynolds, of Ketchikan, also operated a floating plant of considerable importance. A floating plant devoted chiefly to mild-cure and herring work was operated on the steamer *Neptune* in the Cape Fanshaw district by the recently organized Toledo Fish Co. Another company organized this year was the Alaska Cooperative Fishing & Packing Co., composed chiefly of business men and fishermen of Wrangell. A plant was erected at the latter place with storage facilities for 200 tierces of salmon. So far operations have been confined to the handling of mild-cure salmon, but later it is expected that other branches of the industry will be entered. In addition to those mentioned above, there were various other less extensive operators in the mild-cure business in southeast Alaska.

In the Dry Bay region, Capt. Malcolm Campbell, of Juneau, engaged in mild-cure operations on the schooner *Standard Fish Co. No. 2*. The fish were taken by means of gill nets, and it is notable that out of a pack of 77 tierces none of the white-meated variety was observed. The small steamer *Dolphin*, operated by John Berg, got a few tierces of kings and a few barrels of sockeyes in the vicinity of Dry Bay.

Central Alaska came into the mild-cure work this year to a more notable extent than heretofore. A few tierces of king salmon were mild cured by L. Mikkelson at Abercrombie, which place is 55 miles out from Cordova on the Copper River & Northwestern Railroad. His principal business was salting red salmon. The Alganik Fish Co. mild cured a few tierces of king salmon in the same region. This season is the first for mild-cure work on the Copper River. In the Cook Inlet country J. A. Herbert, of Seldovia, engaged for the first time this season in mild-cure operations. The fish came chiefly from two traps driven at favorable locations in Cook Inlet. The Puget

Sound & Alaska Fish Co., organized this year at Seattle, sent the schooner *Allie I. Algar* to Cook Inlet, where a successful season was spent mild curing king salmon.

The power schooner *Bender Bros.* was operated by J. E. Shields, of Seattle, in mild-curing operations on the Kuskokwim River in western Alaska. Although more than 150 tierces were packed, the undertaking was not considered a success. The fish did not have the much-desired bright silvery appearance; also, in order to keep the product from spoiling, it was necessary to salt too heavily for mild curing. In the central and western Alaska regions the lack of cold-storage facilities is a bar against effective mild-cure work. It either becomes necessary practically to hard-pickle the salmon or else run the risk of spoiling on account of a lack of proper means of cooling. As in Bering Sea and Cook Inlet waters practically all of the king salmon are red meated.

Statistical Summary.

The investment in mild-cure work this year was $1,165,866, as compared with $326,152 in 1912. Although there was a very notable advance in mild-cure operations this year, part of the gain in investment is due to the inclusion of working capital, which item was not shown in the previous report. The number of fixed plants increased from 15 in 1912 to 20 in 1913. The number of persons engaged increased from 779 in 1912 to 2,644 in 1913. This gain was largely of white fishermen in southeast Alaska. The total product of mild-cured salmon increased from 5,245 tierces in 1912, valued at $399,852, to 7,443 tierces in 1913, valued at $543,362, a gain of 2,198 tierces and $144,510 in value.

Investment in the Salmon Mild-Curing Industry in 1913.

Items.	Southeast Alaska.		Central Alaska.		Western Alaska.		Total.	
	No.	*Value.*	*No.*	*Value.*	*No.*	*Value.*	*No.*	*Value.*
Fixed plants	20	$147,335	1	$500	1	$3,000	22	$150,835
Operating capital	.....	427,000	.....	17,500	.....	5,000	.....	449,500
Vessels:								
Power vessels over 5 tons	41	143,600	2	9,500	1	12,000	44	165,100
Net tonnage	641	.....	114	.....	91	.....	846	.....
Launches under 5 tons	516	300,190	.....	.....	2	600	518	300,790
Sailing	.....	.....	1	4,500	.....	.....	1	4,500
Net tonnage	.....	.....	150	.....	.....	.....	150	.....
Boats, sail and row	1,490	46,967	6	460	7	245	1,503	47,672
Lighters and scows	11	8,350	2	1,500	.....	.....	13	9,850
Pile drivers	.....	.....	1	2,000	.....	.....	1	2,000
Gear:								
Haul seines	4	375	.....	.....	.....	.....	4	375
Fathoms	350	.....	.....	.....	.....	.....	350	.....
Purse seines	6	2,100	.....	.....	.....	.....	6	2,100
Fathoms	690	.....	.....	.....	.....	.....	690	.....
Gill nets	268	20,850	4	400	22	750	294	22,000
Fathoms	28,630	.....	400	.....	650	.....	29,680	.....
Hand lines	5,511	11,144	.....	.....	.....	.....	5,511	11,144
Total	.....	1,107,911	.....	36,360	.....	21,595	.....	1,165,866

PERSONS ENGAGED IN THE SALMON MILD-CURING INDUSTRY IN 1913.

Occupations and races.	Southeast Alaska.	Central Alaska.	Western Alaska.	Total.
Fishermen:				
Whites	2,087	21	5	2,113
Indians	272			272
Shoresmen:				
Whites	134	2	7	143
Indians	10	5	40	55
Chinese			1	1
Transporters:				
Whites	46	8	2	56
Indians		4		4
Total	2,549	40	55	2,644

PRODUCTS OF THE SALMON MILD-CURING INDUSTRY IN 1913.

Species.	Number tierces.	Pounds.	Value.
Southeast Alaska:			
King salmon	6,787	5,476,364	$504,382
Coho salmon	[a] 286	233,697	11,195
Total	7,073	5,710,061	515,577
Central Alaska: King salmon	219	177,850	17,785
Western Alaska: King salmon	151	124,575	10,000
Total:			
King salmon	7,157	5,778,789	532,167
Coho salmon	286	233,697	11,195
Grand total	7,443	6,012,486	543,362

[a] Includes 6 tierces chum salmon.

PICKLED SALMON.

Early in the season prospects for a remunerative return on pickled salmon were so unalluring that interest in this field of endeavor was much lessened. This was particularly true of southeast Alaska, where mild-cure operations and the demands for canning diverted attention from the pickling of salmon. As a matter of fact, the only concern in southeast Alaska engaged in a strictly pickling venture this season was the Holbrook Fishing & Packing Co. In central Alaska there was considerable activity along this line, although the Cordova Fish Packers Association, which was organized in 1912 and put up a good sized pack of salt salmon, did not operate this year. Saltery operations were conducted near Katalla, at Abercrombie (on the Copper River), at Eshamy Bay, at Seward, and at two salteries in the Kodiak region. It was in western Alaska that the greatest activity in salt salmon occurred. The heavy run of reds, and the overtaxing of canning facilities stimulated salting operations very perceptibly.

The saltery doing business under the name of the Lagoon Salmon Co., at Nelson Lagoon in western Alaska, was operated again this

season by Libby, McNeill & Libby under option of purchase. This company also acquired the saltery on the Igushik River formerly owned by the Alaska Fishermen's Packing Co.

The Port Heiden Packing Co. this year operated for the first time a salting station at Port Heiden, using the brigantine *Harriet G.* (188 tons) as a base of operations. Salting has been carried on at this place from time to time in a desultory manner, but never heretofore with any reputed degree of financial success.

This year Peter M. Nelson, whose former salting station on the Igushik River was absorbed by the Alaska Fishermen's Packing Co. in 1910, built and operated successfully a small plant of similar character near Kogiung. Some of the material for this plant was brought from the old Bear River saltery near Port Moller.

Salmon Bellies.

There has been more activity in putting up salmon bellies this year than for a season or so past. The supply has not been equal to the demand, and there has been resort to the plan of cutting bellies from pickled salmon. In southeast Alaska, where interest waned in the canning of chums this season, a profitable utilization of bellies might have been made. The chum belly is larger and better than the humpback belly. At one plant in southeast Alaska chum bellies were put up and the backs were dry salted for exportation to the Orient.

In view of the fact that during the past season the business of pickling salmon bellies has shown a marked increase, it seems proper again to invite attention to an order promulgated by the Commissioner of Fisheries on April 18, 1908, directing attention to the necessity of disposing of the remaining edible portion of the fish when bellies are pickled.

The order in question is as follows:

NOTICE TO PACKERS OF SALMON IN ALASKA.

It is desired to call the attention of all packers of salmon in Alaska to section 8 of the act for the protection of the fisheries of Alaska, approved June 26, 1906, which reads as follows:

"Sec. 8. That it shall be unlawful for any person, company, or corporation wantonly to waste or destroy salmon or other food fishes taken or caught in any of the waters of Alaska."

The present methods of preparing the bellies of salmon for the market involve the waste of a large part of the edible portion of the fish. It is believed that this waste is contrary to the spirit and letter of the above provision. The Secretary of Commerce and Labor, who is charged with the enforcement of the Alaska fisheries act, has notified this Bureau that the practice of curing and preserving the so-called belly of the salmon which results in the waste of a large proportion of the edible portion of the fish, is a wanton waste within the meaning of section 8 above, and that after January 1, 1909, those who engage in this practice will be reported for prosecution, as provided for in the act.

From the foregoing it will be noted that the law does not forbid the preparation of salmon bellies, but it forbids waste of good material, which has frequently occurred in the past.

Favorite methods of disposing of the remaining portion of the fish are dry-salting or use for dog food.

Statistical Summary.

There were 24 salteries in operation this year as compared with 26 in 1912, and the number of persons employed was lessened from 538 to 478. The investment, however, shows an increase from $387,565 in 1912 to $445,377 in 1913. The production was larger this year, but brought a smaller price. In 1912 the production was 34,639 barrels, valued at $306,534, while in 1913 it was 38,332 barrels, valued at $279,249. Approximately 77 per cent of the product this year was prepared in the Bristol Bay region.

Investment in the Salmon Pickling Industry in 1913.

Items.	Southeast Alaska.		Central Alaska.		Western Alaska.		Total.	
	No.	*Value.*	*No.*	*Value.*	*No.*	*Value.*	*No.*	*Value.*
Salteries	7	$28,697	11	$24,150	6	$83,500	24	$136,347
Operating capital	.....	17,600	.....	31,100	.....	129,000	.....	177,700
Vessels:								
Power vessels over 5 tons	3	9,500	3	21,000	3	16,800	9	47,300
Net tonnage	61	.....	68	.....	34	.....	163	.....
Launches under 5 tons	2	2,000	2	1,000	2	3,650	6	6,650
Sailing	.....	.....	.....	.....	4	26,500	4	26,500
Net tonnage	.....	.....	.....	.....	1,287	.....	1,287	.....
Boats, sail and row	17	595	46	2,780	59	9,680	122	13,055
Lighters and scows	4	1,200	2	1,600	17	7,840	23	10,640
Pile drivers	.....	.....	1	800	3	5,000	4	5,800
Gear:								
Haul seines	5	780	16	1,955	1	100	22	2,835
Fathoms	475	.....	1,400	.....	75	.....	1,950	.....
Purse seines	2	650	.....	.....	1	600	3	1,250
Fathoms	175	.....	.....	.....	175	.....	450	.....
Gill nets	9	415	40	2,443	65	6,410	114	9,268
Fathoms	535	.....	2,980	.....	8,640	.....	12,155	.....
Traps, driven	.....	.....	1	2,000	4	6,000	5	8,000
Dip nets	1	2	6	30	.....	.....	7	32
Total	.....	61,439	.....	88,858	.....	295,080	.....	445,377

Persons Engaged in the Salmon-Pickling Industry in 1913.

Occupations and races.	Southeast Alaska.	Central Alaska.	Western Alaska.	Total.
Fishermen:				
Whites	16	43	90	149
Natives	12	64	21	97
Total	28	107	111	246
Shoresmen:				
Whites	12	22	102	136
Natives	25	24	34	83
Japanese	2	1	.....	3
Total	39	47	136	222
Transporters:				
Whites	.....	1	3	4
Natives	.....	5	1	6
Total	.....	6	4	10
Grand total	67	160	251	478

BARRELS[a] OF SALMON PICKLED IN 1913, BY SPECIES.

Products.	Southeast Alaska.		Central Alaska.		Western Alaska.		Total.	
	No.	*Value.*	*No.*	*Value.*	*No.*	*Value.*	*No.*	*Value.*
Coho, or silver	476	$2,980	88	$734	442	$2,738	1,006	$6,452
Coho bellies	.....	.....	38	706	16	240	54	946
Dog, or chum	95	760	.....	.....	5	18	100	778
Chum bellies	59	775	1	16	7	150	67	941
Humpback, or pink	2,289	15,635	435	2,546	.....	.....	2,724	18,181
Humpback bellies	284	4,065	40	481	.....	.....	324	4,546
King, or spring	.....	.....	26	260	109	1,150	135	1,410
Red, or sockeye	69	598	5,091	36,610	28,756	208,697	33,916	245,905
Red bellies	.....	.....	6	90	.....	.....	6	90
Total	3,272	24,813	5,725	41,443	29,335	212,993	38,332	279,249

[a] Barrels holding 200 pounds of fish.

FRESH SALMON.

SHIPPED FROM ALASKA.

As for several years past, considerable attention was devoted during 1913 to the shipment of fresh salmon to Puget Sound from Petersburg, Wrangell, Juneau, and Ketchikan. The fish are packed in ice in boxes holding about 450 pounds and are handled by the regular steamship lines. This year shows a falling off in the quantity of salmon handled in a fresh state, which condition may be explained by the fact that other means of disposal have seemed to offer a more substantial return. The records show that during 1913 shipments of fresh salmon from Alaska aggregated 645,956 pounds, valued at $51,727. In 1912 shipments totaled 1,188,649 pounds, valued at $87,463.

MARKETED LOCALLY IN ALASKA.

No definite figures are available as to the exact quantity of fresh fish distributed and consumed in Alaska through the local markets. With the increase of population, particularly in certain sections of southeast Alaska, this industry has grown to considerable proportions. Careful estimates place the total consumption of fresh fish purchased either at local markets or from fishermen at 500,000 pounds, valued at $40,000. Of this, 50 per cent is halibut, 35 per cent salmon, and 15 per cent is miscellaneous fishes, including black cod, herring, bass, and other species. Local prices vary from an average of 7 cents per pound for halibut to 10 or 12 cents for salmon.

FROZEN SALMON.

The freezing of Alaska salmon was carried on in connection with other cold-storage business at several different plants in Alaska. These included the Taku Canning & Cold Storage Co. at Taku Harbor, J. Lindenberger (Inc.) at Craig, the New England Fish Co. at Ketchi-

kan, and the Columbia & Northern Fishing & Packing Co. at Wrangell, which establishments operated prior to this year, and the new plants of the Juneau Cold Storage Co. at Juneau, the Booth Fisheries Co. at Sitka, and the floating cold-storage ship, *Glory of the Seas*, operated by the Glacier Fisheries Co. at Idaho Inlet. Another cold-storage plant is now in process of construction at Ketchikan. The Weiding & Independent Fisheries Co., which had the combined floating cannery and cold-storage ship *William H. Smith* at Saginaw Bay last season, was the only withdrawal from the frozen-fish field in Alaska this year.

In freezing salmon it is essential that they be sleek and smooth, as a bruised appearance makes them unprofitable to market. For this reason it is better to freeze salmon that are caught in traps, as they are less apt to be marred in handling than those taken in seines and other gear.

During 1913 salmon were frozen to the extent of 701,418 pounds, valued at $28,057. This is a gain of 250,359 pounds and $7,770 in value as compared with 1912.

SALMON FROZEN IN ALASKA IN 1913.

Species.	Pounds.	Value.
Coho salmon	340,908	$16,425
Dog salmon	330,537	10,406
King salmon	29,973	1,226
Total	701,418	28,057

MINOR PRESERVING PROCESSES.

SPECIAL PRODUCTS.

Though there is a strong modern-day tendency to specialize in food products along the line of novelties put up in attractive and fancy ways, the field of special fishery products has not been developed proportionately with others. This is particularly true as regards combination products having fish as the chief constituent. The notable exception so far as Alaska is concerned, has been the work of the Revilla Fish Products Co. at Ketchikan, where, in 1912, several thousand cases of fish pudding, smoked salmon loaf, smoked fish loaf, deviled halibut, and canned halibut were put up. In addition to the salmon, cod, or halibut which formed the base of these preparations, cereals, oils, and spices were used. This company is the first to engage in the preparation of these products, and their high grade and attractive appearance warrant a hearty reception at the hands of the public. The chief difficulty to date has been a lack of proper advertising to acquaint the trade and market with the merits of the product. With a little more time and means to advertise and demon-

strate these specialties, a good trade ought to be built up. The Revilla Fish Products Co. did not operate during the season of 1913.

Another special product that might be prepared is salmon caviare. The process involved consists of salting, screening, and packing the roe in glass jars with a tin top, or in other suitable containers. A wholesome product can be prepared profitably and at a price that will put it within common reach. A small quantity was prepared this year.

Kippered Salmon.

A field which would seem susceptible of profitable and extensive expansion, particularly in southeast Alaska, is the smoking or kippering of salmon, perhaps largely the white-meated fish. Neither as a mild-cured nor as a canned product does the white king command a price commensurate with its real value as compared with its more favored kin of higher color. Therefore, in casting about for means of utilizing the white king to better advantage, consideration might well be given the plan of preparing a smoked or kippered product. A ready market is assured.

Last year William E. Lloyd, of Wrangell, prepared a limited amount of this very palatable salmon product, and this year the work was prosecuted somewhat more vigorously. Local demands are about all that have been taken account of so far. This season C. B. Ferguson, of Craig, smoked 5,900 pounds of salmon, valued at $498.

As a feature of its new plant at Juneau, the Juneau Cold Storage Co. has installed a large and substantial smokehouse, where it is intended to prepare various kippered products.

Dry Salt Salmon.

At M. E. Lane's saltery at Union Bay, 100,000 pounds of pink and chum salmon backs were dry-salted for the oriental market. This work was incidental to the salting of bellies, and was adopted as a means of utilizing the backs. The Admiralty Trading Co. dry-salted 5,282 pounds of chum salmon, and at Metlakahtla 16,000 pounds of pink backs were similarly prepared by John Davis. The total value of the dry salt salmon products this year was $1,235.

Salmon Fishing on the Yukon.

Salmon constitutes the principal diet of many of the natives of interior Alaska. Without the salmon run to depend upon, the lower Yukon natives could not exist, as there is but little other food obtainable. On the Yukon above Kokrines, and on the Tanana, the natives also live principally upon salmon, but they have in addition a variety of big game with which the salmon diet may be supplemented. During their long journey up the Yukon, as far as the Tanana and other tributary streams, the salmon as a rule become quite thin and the

flesh loses its rich and oily characteristic. This is especially true during the latter part of the season. In consequence, the fish are not much esteemed by the white population for use in a fresh state except early in the season.

On the Tanana and Yukon as far down as Nulato small fish wheels are almost entirely used in the capture of salmon, but from Anvik down various rather primitive styles of traps are used. In either case they are usually placed near some rocky point or curve in the river. In the vicinity of Nome a few small seines are used by the Eskimos. The fish taken by the latter are consumed locally. Early in June, soon after the break-up of the rivers, nearly every family of natives starts for the site of its intended fish wheel or trap, as the case may be. The bucks put in the fishing apparatus, after which it is attended by the squaws, who also clean and smoke or otherwise prepare the fish. From June 10 to 15 the king salmon, the first fish of the season, begins to run. This run lasts about a month, and each Indian catches on the average anywhere from 60 to 125 fish. In July the runs of coho and dog salmon begin, and continue until well along in August. It is estimated that during the season an Indian will catch from 300 to 600 coho and from 1,200 to 1,500 dog salmon. A white man will catch several times as many fish as a native, but there are very few white fishermen engaged. They are mostly squaw-men who live and catch their fish near some white settlement where they can dispose of them for dog feed.

Practically all of the salmon caught in the interior of Alaska are smoked and dried, though early in the season a few are sold fresh. The Indians sell the best fish of their catch and eat the remainder or feed it to their dogs. The salmon as dried and sold for dog feed are handled by traders who retail this commodity at prices ranging from 10 to 12½ cents per pound. Most of the fish sold to whites for human consumption are lightly smoked.

HALIBUT FISHERY.

CONDITIONS AND PROSPECTS.

The commercial value of the halibut fishery of the Pacific now greatly exceeds that of the Atlantic, and in Alaska, as in British Columbia, it is second in importance only to the salmon fishery.

The great size of the halibut, the trifling loss of weight in dressing for market, and the generally remunerative price which it commands render its pursuit attractive to the fisherman, while its clean, white, firm-grained flesh and its capacity to withstand much handling and distant shipment, also its susceptibility of preservation in a fresh state for extended periods without serious loss in palatable flavor, find favor alike with dealer and consumer.

In food value the halibut has high rank. Compared with meat its low price and minimum of waste in preparing for the table combine to make it a favorite with an ever-increasing number of consumers. For some years a prejudice against cold-storage halibut from so distant a source as the North Pacific had a tendency to deter its extended use in the Eastern States, but, as a result primarliy of the care exercised in handling and transporting, this has been entirely overcome. The growth of the trade has since been remarkable, with every prospect of a steady continuance under the present methods of distribution.

Judged by statistics of shipments, the Pacific halibut shows no decline in abundance, yet the fact remains that for some years past larger vessels of increasing power and steaming radius have become necessary to supply the market requirements. The greater part of the halibut brought into Pacific ports formerly originated from that wonderful network of channels and fiords which cut into the coasts of British Columbia and southeast Alaska. Now, however, the most important supply is from grounds off the outer coasts, and these grounds are being steadily developed at points more and more remote from the home ports. Small power craft continue to deliver quantities of halibut yielded by the banks of the inner channels, but it is generally conceded that the maximum of their productivity has been reached if not, in some instances, actually passed. While Frederick Sound, Chatham Strait, and Icy Strait, in their wider reaches, continue to receive attention from a few of the larger craft, one of the present favorite grounds for the best-found vessels is that off Yakutat. During the past few months explorations have been carried on by practical fishermen in the Prince William Sound district, and their favorable reports lead to the belief that a considerable development of the industry may follow in that region.

It is a general belief that there is little waste in the halibut fishery, but this is not strictly true. Halibut are almost exclusively caught on trawl or ground lines, which, equipped with hundreds of hooks, are set out from dories in great lengths over the bottom. At intervals, as the weather permits, the lines are under-run, the catch removed, hooks rebaited, and the lines reset, this work also being done from dories. After careful inquiry among halibut fishermen themselves, it is believed to be a safe estimate that for every halibut caught at least one other fish of more or less value as food is taken from the hooks. With those rare exceptions when black cod are retained, all these fish are thrown back into the sea, either dead or soon to perish. Except in so far as they may become food for other species, they may be regarded as a total economic loss. The fishermen have so little space in their dories that they seldom give the cheaper fishes boat room, yet a great many of them have distinct market value. The

most abundant are the red rockfishes and the black cod, with the former predominating in number when all grounds are considered. True cod are found in largest numbers where the depletion of halibut is most pronounced; and deep-sea soles, flounders, and skates are most numerous on a muddy bottom. It is certain that the total quantity of these fishes at present wasted is enormous in the aggregate; in weight it is probably at least one-half that of the halibut itself. That such a situation should not long be allowed to continue is obvious.

Stormy weather, during which it is too rough to work from dories, occurs very frequently during the winter months, and it often happens that a large quantity of gear set out is never recovered. In the meantime the baited hooks resting on the bottom continue to lure and capture fish which are never brought to the surface, and which inevitably come to a miserable end. How important a factor this condition is in the depletion of the grounds is problematical, but in those regions most subject to unfavorable weather it certainly must contribute in no little degree to the threatened future of the fishery. Fishermen freely admit heavy losses of gear, and do not deny that the results of such losses can not help being felt in time. The intervals of fair weather are so infrequent during the period in the region under discussion that every moment when dory fishing may be carried on is taken advantage of, and frequently lines are laid out on the mere chance that they may be recovered later, notwithstanding that all signs point to the contrary.

As a result of this, and probably due in part also to the establishment of cold-storage plants in close proximity to the more prolific fishing localities, another change in the type of vessels and their methods has been inaugurated. This latest development is toward a reduction in the size, power, and cost of maintenance of halibut cruisers. The idea is that they shall be sufficiently large to remain at sea in moderately heavy weather, such as when trawl-line work from dories would be unsafe, and at such times to set, under-run, and reset the lines from the main craft itself. To this end the power "gurdy," a sort of winch for lifting the ground line from the bottom, has been devised and may be expected to come more and more into general use. As the employment of power entails a greater strain on the gear handled, the tendency is toward the use of heavier ground lines, and one dealer in Seattle has already laid in a supply of 36-pound stuff to take the place of the 30 and 32 pound articles at present in vogue.

That a further development of the halibut fishing industry may be expected with the opening of the Panama Canal is not improbable. It is reported that agents of certain Atlantic steamship lines are already planning to equip vessels with cold-storage accommodations of several hundred tons capacity each, with a view to the transporta-

tion of choice fish from north Pacific ports to European markets. With so potential an expansion of market demands, it seems not unreasonable to suppose that the present waste of the food fishes taken incidentally with the halibut may be nullified if present tendencies to save them develop in the manner hoped for. Where the lines are lifted from the bottom by power and the catch is landed on the deck of the cruiser itself there is no reason why all food fishes should not be struck into the hold and carried to a cold-storage plant adjacent to the fishing ground, there to be cared for until shipment to the distributing centers.

In the matter of cold storage and freezing the halibut industry has made notable advances in southeast Alaska this year. The thoroughly wholesome condition and appetizing appearance of the frozen halibut, with its thin coating of clear ice which effects an absolute hermetical sealing, is bringing this fish to the popular attention it rightly deserves.

Three new companies have engaged in cold-storage halibut operations this year as the chief feature of their business. These are the Juneau Cold Storage Co. at Juneau; the Booth Fisheries Co. at Sitka; and the floating plant of the Glacier Fisheries Co. on the ship *Glory of the Seas,* located at Idaho Inlet. The Columbia & Northern Fishing & Packing Co. at Wrangell has also extended its business this year to include cold-storage facilities. Other concerns which engaged again this year in cold storage and other operations were the New England Fish Company at Ketchikan; Taku Canning & Cold Storage Co. at Taku Harbor; and J. Lindenberger (Inc.) at Craig. The combined cold-storage and canning plant operated last year by the Weiding & Independent Fisheries Co. on the ship *William H. Smith* was not sent north this season. The schooner *Metha Nelson,* which did cold-storage work in the vicinity of Kodiak last year, was not operated this season.

The new plant of the Booth Fisheries Co. at Sitka appears to be very favorably located as regards proximity to the halibut grounds. A modern plant has been erected with storage capacity of 500,000 pounds; two sharp freezers have been installed with a total daily capacity of 25,000 pounds. Announcement has been made that the plant will be enlarged soon.

In addition to other features of its business, the Juneau Cold Storage Co. has storage capacity of upwards of 300,000 pounds of frozen fish. A 14-ton ice plant has been installed and there is storage space for 150 tons of ice. Although the principal business of the Columbia & Northern Fishing & Packing Co. at Wrangell this season has been the mild curing of king salmon, a considerable quantity of halibut has been frozen. A sharp freezer of 10 tons capacity has been installed and there is storage room for 150,000 pounds of frozen fish.

A very complete cold-storage plant was installed by the Glacier Fisheries Co. on the ship *Glory of the Seas*, which vessel during the last two years has been operated as a floating cannery. The daily capacity of the sharp freezers is 60,000 pounds, while the total cold-storage facilities will enable the handling of approximately 3,000,000 pounds. The vessel was towed to Idaho Inlet in June and was brought back to Seattle in the fall with the season's product. The Taku Canning & Cold Storage Co. at Taku Harbor has storage capacity for approximately 450,000 pounds of fish. This concern utilized, in part, the barge *Dashing Wave* in connection with its cold-storage operations. The largest cold-storage plant in Alaska is that of the New England Fish Co. at Ketchikan, which now has facilities for handling 100,000 pounds daily and a total storage capacity of 6,000,000 pounds.

In connection with what has been said elsewhere concerning the utlization of those products of the fisheries now generally regarded as waste, it may not be out of place to call attention to the very considerable quantity of nutritive material which is a part of the head of the halibut. In northwestern Europe this is considered the choicest part of the fish and many delicacies are prepared from it. If the heads of the large numbers of halibut taken in Alaska could reach the hands of such establishments as the Revilla Fish Products Co., at Ketchikan, where various special fishery preparations have already been put on the market, it would appear that a further value might accrue to the halibut fishery.

While fresh and frozen herring continue to be the favorite bait for halibut on the offshore grounds, also on the inside banks during the winter months, it has been found that fresh salmon is a superior attraction in the regions adjacent to the canneries and salteries during the salmon-packing season. At this time the halibut are enticed from distant points, probably by the offal from the packing establishments, and as long as the canning season continues a hook baited with a liberal piece of salmon is said to surpass all other lures.

The serious strike of halibut fishermen operating chiefly from headquarters on Puget Sound, which began on November 14, 1912, was amicably terminated about the first of February of the present year. Since this time no further labor disturbances have occurred.

The only serious disaster to the halibut fleet during the season of 1913 was the loss of the steamer *Weiding*, formerly the *Weiding Bros.*, of Seattle (120 net tons), which was sunk off the Queen Charlotte Islands on July 23. No lives were lost. Weather conditions were remarkably favorable to halibut-fishing operations until early in September, subsequent to which an unusual series of storms succeeded each other to the close of the year.

While vague and unconfirmed reports of halibut poaching by Canadian fishermen in American waters have been heard from time to time, it is not believed that it has been indulged in to any considerable extent. On the other hand, complaint is made that American fishermen are not accorded the same measure of accommodation in transit that is granted to the Canadians. The most common demur is that while British vessels regularly take on fuel, bait, and other supplies in Alaskan ports, similar practices by Americans are discouraged by the Canadian authorities. It is understood that a bill permitting American fishing vessels to enter British Columbia ports to take on bait is now before the provincial parliament. It is to be hoped that the bill may become a law.

During December, 1913, one of the revenue cutters gave attention to the question of whether alien vessels were taking halibut within the 3-mile limit on the lately developed banks between Yakutat and Prince William Sound. It was found that most of the fish are taken in depths of from 40 fathoms to the 100-fathom curve, which in this region are at least 3 miles offshore.

STATISTICAL SUMMARY.

On account of the entrance of four new companies in the halibut-freezing business and the construction of new vessels the investment in halibut operations increased from $2,036,050 in 1912 to $2,360,025 in 1913, a gain of $323,975. The number of persons engaged also increased from 1,038 in 1912 to 1,256 in 1913, a gain of 218 persons. More activity was displayed this year by small power boats operating on the inside reaches. These small boats fished chiefly for the cold-storage plants. Returns show that the weight of prepared halibut products credited to Alaska in 1913 is 13,437,784 pounds as compared with 16,896,743 pounds in 1912, a decrease of 3,458,959 pounds. The figures shown refer to all vessels fishing for plants operated in Alaska, as well as those vessels from Puget Sound fishing in Alaska waters, with the exception that catches from extra-territorial waters of Alaska landed directly at Puget Sound ports by the fishing vessels are not included.

INVESTMENT IN THE ALASKA HALIBUT FISHERIES IN 1913.

Items.	Number.	Value.
Fishing vessels, steamer and power	162	$1,212,000
Tonnage	3,327	.....
Outfit	.....	582,225
Boats:		
Dories	441	22,050
Sail	6	575
Apparatus: Trawls and fishing gear	.....	73,175
Shore and fixed property	.....	470,000
Total	.....	2,360,025

PERSONS ENGAGED IN THE ALASKA HALIBUT FISHERIES IN 1913.

Races.	Number.
Whites	1,216
Natives	40
Total	1,256

PRODUCTS OF THE ALASKA HALIBUT FISHERIES IN 1913.

Products.	Pounds.[a]	Value.
Halibut:		
Fresh	3,642,163	$114,277
Frozen	9,987,310	454,320
Dry salted	21,159	830
Fletched	37,152	1,887
Total	13,687,784	571,314

[a] Prepared weight.

COD FISHERY.

The cod industry in Alaska waters has been in a flourishing condition this year. All vessels took full fares, and the shore stations did well. This may be accounted for largely by the fact that, taken as a whole, weather conditions for the inside operations at the shore stations, also in Bering Sea, were unusually favorable. The offshore vessel catch in the Pacific, however, was considerably lessened by heavy weather.

One man was lost from the schooner *Fanny Dutard*, of the Matheson Fisheries Co., and the Union Fish Co. lost a man from one of its shore stations.

VESSEL FISHERY.

On the night of March 29, returning from the Alaska shore stations with a cargo of 145,000 codfish, the schooner *John D. Spreckels*, operated by the Alaska Codfish Co., was run down off the California coast by the steamship *Statesman* and lost. A heavy fog was responsible for the disaster. Two seamen on the schooner were crushed to death. The cargo also was lost.

The Pacific Coast Codfish Co. operated for the first time this season the 328-ton schooner *Charles R. Wilson*. This company also had the the schooner *John A.*, which has been in service for several seasons. Operations were confined to sea fishing. The Blom Codfish Co. did not send the schooner *Fortuna* north this year.

Early in the season the Union Fish Co. equipped the schooner *Vega* (233 tons) and the power schooner *Union Jack* (39 tons) with trawl lines designed on the general plan of halibut trawls. Virtually the

entire catch of these vessels was made in this way. Each dory with two men used 14 ground lines to a set, each ground line being 50 fathoms long and having 75 hooks. The *Vega* fished outside in water as deep as 120 fathoms, while the *Union Jack* operated on the inside Shumagin banks in from 50 to 70 fathoms of water.

Later in the season an Atwood net lifter operated by a 4-horsepower gasoline engine was installed on the *Union Jack* and was found to operate very successfully in lifting the trawls. This type of lifter is much the same as that employed on the Great Lakes for handling gill nets in lake trout and whitefish operations. A marked advantage of using the lifter in Alaska for cod work is that since the entire operation is from the deck of the vessel, it can be continued when heavy weather makes dory fishing impossible.

In its cod operations the Union Fish Co. also experimented successfully with gill nets set on the bottom in from 50 to 70 fathoms. About 7½ inches appears to be the best size of mesh. Each net was 125 yards long and 15½ meshes deep and heavily leaded. Special cedar floats were used, but since they get waterlogged an aluminum float is better.

Plans are under way for the experimental use this winter of a small beam trawl in the central Alaska cod fishery.

The following vessels were operated in connection with the Alaska cod fishery this year:

ALASKA COD FLEET, 1913.

Names.	Class.	Net tonnage.	Operators.
Fanny Dutard	Schooner	252	Matheson Fisheries Co., Anacortes, Wash.
Maid of Orleans	do	171	Do.
Alice	do	220	Robinson Fisheries Co., Anacortes, Wash.
John A	do	235	Pacific Coast Codfish Co., Seattle, Wash.
Charles R. Wilson	do	328	Do.
W. H. Dimond	do	376	Alaska Codfish Co., San Francisco, Cal.
John D. Spreckels [a]	do	253	Do.
City of Papeete	Barkentine	370	Do.
Nonpareil	Power schooner	31	Do.
Ottilie Fjord	Schooner	247	Pacific States Trading Co., San Francisco Cal.
Bertha Dolbeer [b]	do	230	Do.
Vega	do	233	Union Fish Co., San Francisco, Cal.
Galilee	do	328	Do.
Sequoia [b]	do	324	Do.
Golden State [b]	Power schooner	223	Do.
Union Jack	do	39	Do.
Volcano	Schooner	17	Do.
Martha	do	14	Do.
Union Flag	Power schooner	7	Do.

[a] Wrecked Mar. 29, 1913. [b] Transporting vessels.

SHORE STATIONS.

Shore stations were situated as follows: Alaska Codfish Co.: Unga, Squaw Harbor, and Kellys Rock, on Unga Island; Companys Harbor and Murphys Cove, on Sannak Island; and Dora Harbor, on Unimak

Island. John H. Nelson: Squaw Harbor, Unga Island. R. H. Johnson: Hard Scratch, Unga Island. Pacific States Trading Co.: Northwest Harbor, Herendeen Island. Union Fish Co.: Pirate Cove, Popof Island; Northwest Harbor, Herendeen Island; Pavlof Harbor and Johnson Harbor on Sannak Island; Unga, on Unga Island; and Dora Harbor, on Unimak Island.

Summarizing the foregoing, the Alaska Codfish Co. and the Union Fish Co. each operated six shore stations, while the Pacific States Trading Co., John H. Nelson, and R. H. Johnson had one each. Of this total of 15 stations, 6 were on Unga Island, 4 on Sannak Island, 2 each on Herendeen and Unimak Islands, and 1 on Popof Island.

The business of R. H. Johnson and John H. Nelson, whose plants are on Unga Island, was largely the preparation of stockfish. This is a hard-dried form of cod, and is usually shipped in bales. In southeast Alaska the Kake Packing Co. experimented with the canning of cod. It is said that a very attractive product was prepared. The results bespeak further endeavor along this line.

The price of cod has been strong this season, owing chiefly to light catches on the east coast.

STATISTICAL SUMMARY.

The statistics relating to the foregoing vessels are included in the tables. Up to last year figures for vessels have been in part omitted.

The total investment in the cod fishery in 1913, inclusive of both offshore vessel and shore station operations, was $581,107, as against $274,674 for 1912. The increase is due to the addition of vessels to the fleet, enlarged production, and the inclusion of approximately $150,000 more cash capital. The number of persons engaged was 531, including 5 natives and 1 Japanese. This is a gain of 46 persons over 1912. Figures for persons employed at the plants in the States are not included.

The catch totaled 11,916,500 pounds of prepared products, valued at $357,711. This shows a substantial gain over the 1912 production of 8,064,853 pounds, valued at $218,268.

INVESTMENT IN THE COD FISHERY IN ALASKA IN 1913.

Items.	Number.	Value.	Items.	Number.	Value.
Vessels:			Apparatus:		
Power vessels	4	$80,000	Hand lines	977	1,406
Tonnage	290	.....	Trawl lines	.....	700
Launches under 5 tons	3	3,200	Gill nets	100	1,500
Sailing vessels	15	142,100	Cash capital	.....	214,851
Tonnage	3,622	.....	Value shore stations	.....	122,620
Boats, row	400	14,730	Total	.....	581,107

PERSONS ENGAGED IN THE ALASKA COD FISHERIES IN 1913.

Occupations and races.	Number.	Occupations and races.	Number.
Fishermen:		Transporters:	
Whites	424	Whites	53
Natives	5	Japanese	1
Total	429	Total	54
Shoresmen: Whites	48		
		Grand total	531

PRODUCTS OF ALASKA COD FISHERIES IN 1913.

Products.	Prepared weight.	Value.
	Pounds.	
Salted	11,885,500	$355,992
Pickled	15,700	624
Tongues, pickled	8,000	720
Stock fish	7,700	375
Total	11,916,900	357,711

HERRING FISHERY.

GENERAL CONDITIONS.

It is the consensus of opinion that herring have been more numerous this season in the waters of Alaska, and especially in the southeast section aside from the Yes Bay region, than for a number of years past. At no time heretofore has there been anything like an alarming shortage, but as in the case of the herring fishery the world over, there are periodical lean and full years. It not infrequently happens that during the poorer years alarming reports arise to the effect that the supply of herring is being diminished through ruthless fishing operations. Particularly has this view been cited against the practice of utilizing herring in the manufacture of fertilizer and oil.

That this opinion is not borne out in fact has been clearly established by careful and impartial analysis of the situation. So far as Alaska is concerned, the destruction of countless millions of herring in embryo by the natives, who use large quantities of impregnated eggs for food purposes, is a more destructive agency than the use of the adult fish for fertilizer purposes. The natives place brush on the spawning grounds by means of which to remove the eggs. Measures should be taken to prohibit this.

The halibut fishermen are particularly interested in the herring situation, because of the dependence of their industry upon the supply of herring for bait. Much of the agitation as to the fertilizer and oil question has emanated from this source. Unless future developments show radically different conditions as compared with other parts of the world where time has been the infallible test, there will be not only enough herring in Alaska waters to meet present day needs,

both for bait and fertilizer, but will also permit of an expansion along these lines as well as a growth of the food herring industry.

Herring of the sort desired are found at times in great numbers in the coves and estuaries of Frederick Sound and the lower part of Stephens Passage, and, to a lesser extent, are reported in Summer Strait and the southern part of Chatham Strait. They are best in September, October, and November, but by January have usually lost so much fat as to be unfit for the preparation of a high-grade product. In July and August also the southeast Alaska herring are in prime condition, but at that time it is a popular belief that they can not be cured in salt owing to the fact that their stomachs are then engorged with a small crustacean popularly known as "red feed." Much has been said about the impossibility of salting herring which have been subsisting upon red feed, and the statements of John E. Shields, who has had a large practical experience as a fish salter, are of particular interest in this connection. According to Mr. Shields all first-class pickled herring should have the viscera completely removed. If this is done he contends that it makes no difference what the stomach contents may have been—there is no remaining obstacle to a thorough salt cure. He states that it is possible to eviscerate herring in a commercially practical manner by using the nose of a knife, not too sharp, with which to pinch out a section of the throat.

Too much stress can not be laid upon the necessity for careful attention to detail in the preparation of all fishery products intended for use as food. This applies with particular force to salt herring. Too often there has been much carelessness in handling herring. Strictly fresh fish of uniform size, properly eviscerated and thoroughly cured are absolutely essential to a wholesome preserved product. Stale fish, irregular sizes, indifferent curing and packing, and short weights have been the causes for the poor demand hitherto prevailing for Alaska salt herring. With improved methods of preparation and handling now in vogue, a steadily increasing market should be the certain result.

There has been in recent years a growth of the herring industry in the Shumagin Islands and vicinity. The herring of this region, like those occurring in Chignik Bay and Shelikof Strait, are exceptionally large and at times very fat. In size some of these fish are extraordinary, running as large as 200 per barrel, although they will average more often 250. In many of the larger harbors of the eastern islands of the Aleutian chain, notably in Unalaska Bay and Akun Cove, very large and fat herring are known to occur at times in enormous schools, and in Goodnews Bay, near the mouth of the Kuskokwim River, immense numbers of fine fish of the same sort are reported as appearing regularly.

In the Shumagin Island region Ross Boye and others put up several hundred barrels of salted herring. At Craig, in southeast Alaska, C. B. Ferguson smoked several thousand pounds of herring. At various cold-storage plants large quantities have been frozen for halibut bait, the New England Fish Co., at Ketchikan, having engaged in this phase of the work more heavily than any other concern. The fish used by this company come chiefly from the north Behm Canal region. It is well recognized that frozen herring are in every way equal to fresh herring for halibut bait. Salted herring are, however, much inferior for this purpose.

The Griffiths Fish Co. operated extensively in the salt-herring industry during the fall and winter of the current season. The barges *America* (1,908 tons) and *Louisiana* (1,436 tons) were anchored at Convenient Cove and used as floating plants. Fishing operations were conducted in Yes Bay, Spacious Bay, and other near-by waters of the Behm Canal region. The work was carried on mainly by Japanese. Capt. A. W. Thomas and H. Sundsby were also engaged extensively in herring operations in this section.

Although the season was shorter, the catch of herring by the Killisnoo plant was very satisfactory this year. The price of both oil and fertilizer has improved somewhat because of the light take of menhaden on the east coast this season. Part of the fertilizer product has found ready market at San Francisco for use as the base of a very good form of chicken feed. For this purpose particular attention must be paid to reducing the content of oil as low as possible.

Last January at Klawak on the west coast of Prince of Wales Island there occurred an unusually enormous run of herring. So numerous were the fish as they crowded into the bay that hundreds of thousands or even millions were stranded and suffocated. When the tide receded they were left in a solid mass over the beach to a depth in places of several feet. This is an evidence of the abundance of herring in southeast Alaska during the current year.

In Norway a custom has long existed of setting a net across the mouth of a favorable arm of the sea or bay for the purpose of impounding schools of herring. The fish are thus kept alive and may be removed at leisure. There has been a recent tendency among fishermen familiar with this custom of northern Europe to apply it in the herring fishery of southeast Alaska. A specific case occurring in the vicinity of Petersburg last winter resulted in the arrest of a fisherman, Rasmus Enge, who was charged by another fisherman, Nels Husvig, with grand larceny on the ground that the said Enge seined up 2,000 barrels of herring within a lagoon where they had been impounded by the net stretched from shore to shore by Husvig. The matter was finally settled out of court.

The case is peculiar, in that it was Husvig, the complainant, who was guilty of violating the law, though probably through ignorance, for the fisheries law of Alaska prohibits the casting of a net or fishing appliance for more than one-third the distance across any body of water. The inhibitory distance clause appears in section 4 of the act of June 26, 1906, in reference to salmon fishing, but section 11 of the same act extends all of the limitations affecting salmon to other species, which, of course, includes herring. So long as the present law is in effect, any stretching of seines or other nets from shore to shore in the waters of Alaska for the purpose of impounding herring or other food fishes as herein described will in future result in prosecution of the person or persons involved.

Considerable agitation occurred near the close of the year at Craig, on the west coast of Prince of Wales Island, on account of alleged wasteful practices upon the part of nonresident fishermen engaged in herring operations. It was claimed that only the largest and best herring were retained, while the others were thrown away. An investigation of the matter by Deputy Warden Walker resulted in a fine of $200 being imposed December 22 upon Nels Husvig.

Under the chapter on whaling, elsewhere in the report, will be found a discussion of the erroneous popular impression that the killing of whales has an injurious effect upon fishing operations, especially in the case of herring.

STATISTICAL SUMMARY.

The statistics show a decline in the herring fishery of 1913 as compared with 1912, which latter year was particularly good. The total investment for 1913 was $261,480, as compared with $338,890 in 1912, a falling off this year of $77,410. The number of persons engaged in 1913 was 200 as against 339 in 1912. The value of the products declined from $239,278 in 1912 to $191,105 in 1913, a reduction of $48,173.

INVESTMENT IN THE HERRING FISHERY IN ALASKA IN 1913.

Items.	Southeast Alaska.		Central Alaska.		Total.	
	Number.	*Value.*	*Number.*	*Value.*	*Number.*	*Value.*
Fishing vessels:						
Steamers and launches	9	$37,700			9	$37,700
Tonnage	209				209	
Sailing	2	26,000			2	26,000
Tonnage	3,251				3,251	
Launches under 5 tons	5	5,700			5	5,700
Boats, sail and row	19	1,675	6	$180	25	1,855
Scows	8	4,800			8	4,800
Pile drivers	2	1,000			2	1,000
Apparatus:						
Haul seines	2	150			2	150
Purse seines	14	9,800			14	9,800
Gill nets	4	250	14	375	18	625
Traps, stake	2	1,400			2	1,400
Cash capital		115,250				115,250
Shore and accessory property		56,000		1,200		57,200
Total		259,725		1,755		261,480

PERSONS ENGAGED IN THE ALASKA HERRING FISHERIES IN 1913.

Occupations and races.	Southeast Alaska.	Central Alaska.	Total.
Fishermen:			
Whites	54	7	61
Japanese	18	.....	18
Total	72	7	79
Shoresmen:			
Whites	78	.....	78
Japanese	33	.....	33
Chinese	10	.....	10
Total	121	.....	121
Grand total	193	7	200

PRODUCTS OF ALASKA HERRING FISHERIES IN 1913.

Products.	Southeast Alaska.		Central Alaska.		Total.	
Herring:	*Quantity.*	*Value.*	*Quantity.*	*Value.*	*Quantity.*	*Value.*
Fresh, for bait ..... pounds..	3,936,500	$22,245	.....	.....	3,936,500	$22,245
Frozen, for bait..... do....	231,935	2,291	.....	.....	231,935	2,291
Pickled, for food..... barrels..	3,036	23,223	426	$3,609	3,462	26,832
Pickled, for bait..... do....	1,381	3,297	.....	.....	1,381	3,297
Dry-salted, for food... pounds..	5,259,520	50,183	.....	.....	5,259,520	50,183
Fertilizer ..... do....	2,400,000	33,000	.....	.....	2,400,000	33,000
Oil ..... gallons..	260,000	52,000	.....	.....	260,000	52,000
Smoked, for food..... pounds..	17,371	1,257	.....	.....	17,371	1,257
Total	.....	187,496	.....	3,609	.....	191,105

WHALE FISHERY.

SHORE STATION OPERATIONS.

On account of unprofitable returns in 1912, but one concern operated a shore whaling station in Alaska during the season of 1913. This was the United States Whaling Co., whose plant is located at Port Armstrong near the southern end of Baranof Island. The station built on Akutan Island in 1912 by the Alaska Whaling Co. was not operated this year. Likewise operations of the Tyee Co. were suspended. In fact this company has been dissolved, the shore station at Tyee having passed into the hands of the Vendsyssal Packing Co., which used it for mild-curing salmon this season.

Last year the United States Whaling Co. had the Norwegian steamer *Somerstadt* (2,777 tons) as a floating plant auxiliary to the shore station at Port Armstrong. This vessel put in part of the season at the Shumagin Islands. This year operations were confined solely to the Port Armstrong plant. The company operated the killing boats, *Star I*, 133 tons net burden, and the *Star II* and *Star III*, each of 97 net tons. Their normal cruising radius did not extend more than 60 miles from the station. It was observed that whales in this region almost always move in a general northerly direction.

The killing boats are of the modern type common to whale fishing. At the bow of each is mounted a muzzle-loading whale gun of 3¼-inch bore. These guns are now fitted with recoil cylinders, which is an improvement over the original form of Svend Foyn gun. The charge of black powder in a bag is first put in, then a bunch of waste, and next the harpoon, to which is attached the line leading back to the steam winches which are made to play a whale after it is struck, in manner similar to that of the angler who plays his catch. Outside the gun and made a part of the harpoon is the bomb, with expanding arms and so timed as to explode within the whale. The average shooting distance is about 120 feet. In rough weather it is difficult to hit a whale on account of motion both of the vessel and the animal, and this factor has much to do with the success or failure of whaling operations. Unfavorable weather was experienced, particularly during the early part of this season's operations.

Sperm whales generally run in schools. One day, July 24, the three killing boats got 11 sperms, which considerably overtaxed the station's capacity. Sperms are more indifferent to the approach of a vessel; hence are easiest to kill. Heretofore the trouble has been a scarcity of this species, which is exceeded in value only by the great bowhead of the Arctic.

In 1912, when the United States Whaling Co. established its station at Port Armstrong, arrangements were not made to dispose of any portion of the carcasses other than the blubber and gill bone. With the advent of the season of 1913 the plant was much enlarged and additional machinery was installed, so that all of each carcass could be utilized. This process includes the preparation of oil from the blubber, also from the meat and bones, and the reduction of the residue to fertilizer. In anticipation of the installation of fertilizer machinery in 1913, the carcasses of whales taken in 1912, after being stripped of their blubber, were cut up and piled out of doors near the plant. The material thus accumulated was worked up this season into fertilizer, though much of its value was lost through action of the elements.

The plant as it now stands is capable of handling 500 whales a season. The main building is 200 by 80 feet, in addition to which is a large warehouse for storage of fertilizer. There are also quarters for employees and various minor buildings.

When a whale is to be processed, it is hauled up by a winch on an inclined platform, and the blubber is torn off in strips, also by means of a winch, flensing knives having first been run along the body of the animal to cut the strips. The blubber is then cut up by revolving knives and is lifted in a conveyor to the blubber boilers, which are of open-top pattern, about 6 feet in diameter and 12 feet high. Steam is turned into these boilers or cookers for six or eight

hours, after which the oil is drawn off and the mass is similarly cooked again. Sometimes even three cookings are required to obtain all of the oil. Blubber varies in this respect. The oil comes out at the lower end of the boilers and is pumped to the settling tanks, where it remains 24 hours or more and is then barreled for shipment.

After the blubber has been removed a winch hauls the carcass up a steep incline to the upper floor of the main building, which is level with the tops of the 15 meat boilers (each 8 by 10 feet), and the 4 bone boilers (each 10 by 12 feet), which stand on end. Armed with long flensing knives, a crew of Japanese cut up the meat into 30 or 40 pound chunks and it is put into the meat boilers. Tops are screwed fast to these boilers, and the mass is given one cooking for 8 or 10 hours at a pressure of 65 pounds. The oil is drawn off on one side at the bottom, while on the other side is a door through which the residue of solids is removed. It then goes to the drier for conversion into fertilizer.

After the carcass has been cut up, a process which takes 10 men 6 or 8 hours in the case of a good-sized whale, the bones are put into the bone boilers, where they are given a single cooking in steam lasting from 20 to 24 hours, also under a pressure of 65 pounds. The bones are rich in oil which grades as no. 2, whereas the oil from the meat is poorer in quality and grades as no. 3. The bones when taken from the boiler are light in weight and of porous appearance. They go to the bone crusher, then through the drier, and after cooling the material is ground and sacked ready for the market.

The residue from the meat boilers is also put through the drier, is allowed to cool, and is then pulverized and sacked. Each sack holds about 200 pounds. At present prices meat fertilizer is worth about $3 a sack, while bone fertilizer is worth $2.50. The latter is of a grayish color, while the meat fertilizer is a deep brown.

It has been found that the meat from the sulphur bottoms must be more thoroughly cooked in the boilers, since it is slower to dry than meat from other species of whales. When processing sperm whales the first step is to sever the head and remove the oil from the cavity therein. This is a very high-grade and valuable oil. Each sperm produces from 10 to 20 barrels. On account of this proceeding, it takes considerably longer to dispose of a sperm whale.

A deputy customs officer was stationed at Port Armstrong to enter and clear the whaling boats, as they operate chiefly outside the 3-mile limit.

The total catch for the season was 186 whales, of which 126 were males and 60 females. The first whale was killed April 6 and the last September 25. July was the best month, when 55 whales were taken, of which 23 were sperms. It is notable that out of 32 whales captured in April and May but 2 were females, thus indicating an advance

run of males. The take of 73 sperms, nearly 40 per cent of the total catch for the season, is most remarkable. In 1912 all three companies got but 23 sperms out of a total kill of 685 whales.

SAN FRANCISCO WHALING FLEET.

Operations of the San Francisco fleet in northern waters during 1913 amounted to comparatively little. The bark *Gay Head* (252 tons) cleared December 27, 1912, and returned August 30, 1913, with a take of 32,430 gallons of sperm oil, valued at $12,072. The *Gay Head* cleared again October 3, 1913, for a cruise to southern whaling grounds. The steamer *Belvedere* (339 tons) left March 11, 1913, on a whaling voyage to the Arctic. This vessel was frozen in near Griffen Point, and will be forced to winter in the north. The power schooner *Elvira* (60 tons) cleared from San Francisco May 26, on a cruise to the Arctic. On account of unfavorable conditions, this vessel was also seized in the ice, and late in September capsized and became a total loss. The crew escaped over the ice. This vessel was formerly a Japanese seal poacher captured by a revenue cutter and afterwards sold. So far as known at present, no whales were killed this season, either by the *Belvedere* or *Elvira*. The Eskimos succeeded in getting four bowheads near Point Barrow.

The steamer *Karluk*, for many years actively identified with the San Francisco whaling fleet, was acquired by the Stefansson Arctic expedition, and sailed north this spring.

The steamers *Herman* (229 tons), *Beluga* (409 tons), *Bowhead* (243 tons), *Narwhal* (389 tons), and *Thrasher* (502 tons), also the brigantine *Jeanette* (217 tons), did no whaling this year, but were laid up in Oakland Creek.

STATISTICAL SUMMARY.

The total sum invested in shore-station whaling operations was $891,780. This is a decrease of $249,051 from the 1912 season. A total of 99 persons were engaged, of which 73 were whites and 26 Japanese. Last year 303 persons were employed in the industry. The value of the products declined from $311,307 in 1912 to $157,550 in 1913.

WHALES TAKEN IN SHORE OPERATIONS IN 1913.

Species.	Number.	Species.	Number.
Sperm	73	California gray	1
Sulphur bottom	58	Bottlenose	1
Finback	32		
Humpback	21	Total	186

Included in the finbacks above are three whales designated by whalemen as "sei" whales. They are a species of finback, but never

grow to a large size. In all characteristics except size they closely resemble the finback. They have been referred to as the "sharp-headed finner," which attains a length of about 27 feet.

INVESTMENT IN WHALE FISHERY IN ALASKA IN 1913.

Items.	Number.	Value.	Items.	Number.	Value.
Vessels:			Value of plants		$250,000
Steamers	3	$180,000	Cash capital		400,000
Tonnage	327		Wages paid		60,545
Launches under 5 tons	1	435			
Boats, row	5	150	Total		891,780
Lighters and scows	2	300			
Pile drivers	1	350			

PERSONS ENGAGED IN WHALE FISHERY IN ALASKA IN 1913.

Races.	Persons engaged.
Whites	73
Japanese	26
Total	99

PRODUCTS OF ALASKA SHORE WHALING OPERATIONS IN 1913.

Products.	Quantity.	Value.
Whale oil, gallons	466,500	$139,950
Fertilizer, tons	665	17,600
Total		157,550

EFFECT OF WHALING OPERATIONS ON FISHING.

Considerable agitation has developed of late in certain quarters because of the contention that the killing of whales off the Alaska coast has worked great harm to the halibut and herring fisheries, and also affected cod and salmon operations. It is claimed that whales drive the herring toward the shore, where they are followed by the halibut and other species. Thus it is said that if the whales are killed, fishing is bound to be poor.

This theory is open to much question. It is a recognized fact that pelagic fishes have well-defined migratory movements, particularly those general movements toward the shore and to shallower or even fresh water. This is primarily the call of the reproductive instinct. Under the circumstances it seems more reasonable to suppose that the whales follow the herring than to believe that they drive them.

The fact that there has been legislation in Norway prohibitive of whaling is often quoted as evidence that whaling is injurious to other fishing, and particularly to herring operations. In the light of present

information on the subject, it would seem that the prohibition of whaling on the Norwegian coast was more or less involved with politics. In the first place, the decrease of the herring yield, at least during some years, was by the fishing population attributed to the supposition that the schools of herring came into the fiords because they were chased by the whales, and unless there were some whales to do the chasing there would be no herring near the coast; and secondly, whales had been hunted so persistently on the coast for so many years that the number had so decreased as to make whale fishing unprofitable, and those who owned the big establishments in that industry were only too anxious to have the Government stop whaling and remunerate the owners for the values of the plants which thereby became confiscated. Therefore they lent their efforts to the agitation of the fishing population. Men of science in Norway are agreed that the whale has nothing to do with the run of herring or any other fish in Norwegian waters. Any marked or prolonged diminution in the supply of herring could with much more reason be attributed to the energy with which the herring fishery has been prosecuted to meet the demands of a heavy export trade.

FERTILIZER AND OILS.

Operations this season in the manufacture of fertilizer and oil from fishery products were not conducted as extensively as last year. This was due to the fact that two of the whaling establishments did not operate. The companies doing business were as follows: Alaska Oil & Guano Co., Killisnoo; United States Whaling Co., Port Armstrong; W. H. Royden, with a small floating plant; and the Union Fish Co., Shumagin Islands. The products of the first-named company are shown elsewhere under the report on the herring fishery, while the whaling station appears in the section devoted to whaling. Mr. W. H. Royden operated the scow *Elliott* with headquarters at Petersburg, and as a part of his work prepared 16 barrels of shark oil, valued at $200. The Union Fish Co. put up 210 gallons of cod-liver oil, valued at $60. This was merely a minor incident in the season's operations and does not represent any concerted effort in the preparation of oil. The present price is said to be too low for profitable work along this line.

As a phase of the fertilizer and oil situation, more attention ought to be given the manufacture of these products from cannery waste. In other words, put to use every portion of each fish handled, as do the meat-packing establishments their waste products. The meat packer would not long survive if he placed before the public only the choice edible portions of each steer handled and threw away 30 per cent of his raw material, as the salmon packer does. True, the discarded fish material is not proportionately equal in value at present

to the animal material of the packing house, but nevertheless it offers a field in the production of fertilizer and oil, the manufacture of which might well be undertaken by the canning interests. The lack of small and economical units of machinery has heretofore stood in the way, but this situation is being improved.

As bearing upon the manufacture of fertilizer and oil, much interest centers in the plant put in at Klawak this season by the North Pacific Trading & Packing Co. The plant was located in a building convenient to the fish house. An endless conveyer took the gurry from the iron chink to a hopper or iron tank 12 by 12 feet and 4 feet deep. It was then taken by a bucket elevator to the two digestors or cookers, each of about 5 tons capacity. Here the material was cooked in steam for an hour. It was then placed in shallow trays wrapped in burlap and put in the hydraulic press operating at 1,200 pounds pressure. About 1,000 pounds of material could thus be handled at a single operation of the press. Fifteen minutes served to remove the oil and water, which passed to a pit and was then pumped to the settling tanks where the oil and water were separated, the oil being drawn off into barrels. These tanks are of wood, 12 feet long, 4 feet high, and 3 feet wide.

The residue of solids from the press was put in a vertical circular drier, with an agitator revolving about 25 times per minute. It was originally intended to put about 1,000 pounds of material in the drier for each charge, but here a difficulty arose, as it was found that only about 150 pounds could be treated successfully at one time. In other words, it developed that the capacity of the drier was not proportionate with other facilities, or with the requisites in treating the refuse from a cannery packing 1,200 cases a day. This was the principal difficulty experienced, and next year it is the intention to double the drier capacity. After coming from the drier the fertilizer was spread out in the air to aid the drying process. It was then run through a sieve and put up in 100-pound sacks ready for the market. The product commands a price of about $28 per ton delivered at San Francisco. As a result of the season's experimental operations approximately 6 tons of fertilizer and 500 gallons of fish oil were prepared.

Analysis has shown the fertilizer to be rich in ammonia—about 12 per cent—but the sample analyzed contained 16 per cent of oil, which is too much for a strictly high-grade product. It should be reduced to 10 per cent.

An agent of the Bureau of Soils of the Department of Agriculture made some preliminary investigations in Alaska during the summer to consider the matter of converting cannery waste into fertilizer. This was in conjunction with a study of the kelp fields in Alaska waters.

MINOR FISHERIES.

TROUT.

A few hundred cases of Dolly Varden trout were packed by the Midnight Sun Canning Co. at its cannery on Kotzebue Sound. Operations were confined chiefly to the month of August, though another year it is purposed to put the two traps in earlier. The catch was lessened this season because of unfavorable weather, also by schools of belugas which invaded the traps. A number of these were shot, and in the future watchmen will be stationed at the traps to guard against further disturbance from this source.

The plant, which is the most northerly in Alaska, is located on Kotzebue Sound, just outside the mouth of the Noatak River. Aside from two whites and one Japanese, all of the work was performed by Eskimos, both men and women. The plant was built in 1912 and additional buildings were erected this year. It is the intention of the company to specialize on the canning of Dolly Varden trout, which are rich in oils and are said to find a ready sale. The color is a pale pink, but the flesh is not quite as firm as that of salmon. The product is very palatable, however.

At a cannery on Bristol Bay a few cases of trout, chiefly Dolly Vardens, with an occasional small steelhead, were packed this season as a specialty. These fish were butchered and packed by hand and then processed the same as salmon. They were caught incidentally with the salmon, but it was noted that they occurred most plentifully near the beginning and close of the salmon run. For this reason if the canning of trout were developed more extensively it would not interfere so seriously with salmon operations. At any event, during the off years for salmon it would seem a profitable undertaking to pack trout. Under a fancy label it is said that distributors have had no difficulty in marketing at quite remunerative prices the comparatively small quantity packed.

Another phase of the situation is that the salmon will increase proportionately with the canning or destruction of trout, for it is generally conceded that the Dolly Varden and other species of trout are most destructive enemies to both eggs and young salmon. The canning of trout in Alaska should be encouraged and supported in every way.

At the Shumagin Islands this summer a few barrels of Dolly Varden trout were put up at a salmon saltery. The fish were taken incidentally in connection with seining operations for red salmon. In the salting process merely the gills and viscera were removed—the fish not being split open so as to lie flat. Curing was complete but the method of packing was bad, according to commercial standards, and it was difficult to dispose of the product. If the trout had been

split open in the usual manner of preparing pickled salmon, it is said that there would have been no difficulty in marketing them at a profitable figure. Evidence of this may be had in the fact that a few barrels of trout prepared in the orthodox method at a cannery in central Alaska have commanded a price as high as $20 a barrel. A few barrels of pickled Dolly Varden trout were also packed at Eagle Harbor, on Kodiak Island, this season. On Cook Inlet 45 cases of Dolly Varden trout were canned.

As an experiment, a few cases of Dolly Varden trout were put up this season in southeast Alaska by the Kake Packing Co. The fish came from the traps and were put in half-pound flat cans. The experiment was considered a success and further efforts along this line are anticipated.

There has been some misapprehension upon the part of the public regarding the laws of Washington as to the sale of trout. Mr. L. H. Darwin, State fish commissioner and chief game warden, advises that the laws of the State prohibit the sale within the State of all varieties of trout save the Dolly Varden. These are not protected and may be handled commercially. The law also provides that no species of trout, the sale of which is prohibited in the State, may be had in possession, even though it be imported from another State. It will be seen, however, that there is no bar in the State of Washington to the commercial utilization of Dolly Varden trout from Alaska.

PRODUCTS OF THE ALASKA TROUT FISHERY IN 1913.

Sections and species.	Fresh.		Frozen.		Canned.		Pickled.	
	Pounds.	*Value.*	*Pounds.*	*Value.*	*Cases.*[a]	*Value.*	*Barrels.*	*Value.*
Southeast Alaska:								
Dolly Varden	2,780	$194						
Steelhead			5,093	$382				
Total	2,780	194	5,093	382				
Central Alaska: Dolly Varden					45	$153	22	$143
Western Alaska: Dolly Varden					775	2,788		
Grand total:								
Dolly Varden	2,780	194			820	2,941	22	143
Steelhead			5,093	382				
Total	2,780	194	5,093	382	820	2,941	22	143

[a] Each case contains forty-eight 1-pound tall cans.

EULACHON.

The eulachon, candle-fish, or "hooligan" as it is variously termed in Alaska, is a very toothsome member of the smelt family which has a wide distribution in the coastal waters of the territory. It is very rich in oil and possesses food values much in excess of the recognition generally given the species. It is a favorite fish of the natives, who utilize it for food, as well as for the extraction of oil.

In the Juneau markets there has been some call for eulachon, where it is held in high esteem by those acquainted with its merits. One dealer states that there has been some demand for eulahon as a breakfast fish. The Juneau local market has been supplied from the Chilkat River, where eulachon are found in great numbers each spring. Occasionally a supply is brought from Dry Bay, where the average size is better.

Experimentation in the Cook Inlet country by Mr. W. J. Erskine has developed the high value of eulachon for salting purposes, and a very attractive product has been the result. An enormous run of eulachon occurs in Cook Inlet, usually during the last two weeks in May or as soon as the ice goes out. They swarm into the Susitna River in such enormous numbers that they can be easily dipped up as required. No expensive fishing gear is needed. Thus eulachon could be salted at considerably less expense than herring, as the cost of getting the fish would be very little.

BLACK COD.

A fish that has come into well-merited favor during recent years is the black cod (*Anoplopoma fimbria*), a species entirely distinct from the true cod, particularly as regards the rich and oily character of the flesh. Most all of the black cod are taken incidentally in halibut operations. However, in consequence of growing demands, definite sets were made this year, perhaps for the first time in Alaska, with a view primarily to the capture of black cod. These operations were conducted in Chatham and Icy Straits. The same gear and bait are used as in halibut fishing, but sets are made in 300 fathoms or more, as fishermen claim that black cod are found in considerable numbers only at these depths. So far as known at present, the species occurs rather scatteringly in the fiords of the northwestern coast of the continent, and has been found in greatest abundance in southeast Alaska.

Aside from what is consumed locally in Alaska, most of the black cod is handled by Puget Sound wholesalers. In the past they have taken the black cod more as an accommodation to their halibut fishermen than anything else. During the last two years, however, the black cod has been steadily increasing in popularity and is rapidly coming into its own. It is now featured by the leading hotels and restaurants of Seattle.

The principal demand in the Puget Sound market at present is for kippered backs. This usually appears on the menu as "barbecued Alaska black cod." The bellies, which are exceptionally rich and toothsome, are salted down separately. The black cod is said by salt-fish handlers to be one of the best fish for salting purposes found in Pacific waters.

Carelessness in the handling of the black cod has undoubtedly kept its price at a lower figure than so fine a fish ought to bring. Sometimes it comes to the dealers in a hard-salted condition which makes it necessary to soak thoroughly before the smoking or kippering process can be undertaken; again, it has been received in an iced or frozen state, rendering it necessary to thaw out before striking it in salt, which is essential in curing. Few fish can stand this, and while the resulting product is marketable, the practice is undesirable.

The best method of treatment is a mild-cure process, butchering and salting the fletches on the same day the fish is caught. It should then be held at a low temperature until it can be given the light smoking usual in the kippering process, the belly being better suited as a hard-salt article for breakfast consumption.

One of the Seattle brokers is of the opinion that the Puget Sound market will take care of three or four hundred barrels a month. At the present time, salt black cod is worth about $11 a barrel in the Seattle market, whereas formerly the price was not over $7.

Until quite recently practically the entire production of black cod was consumed locally in Alaska, but within the last two or three years shipments to Puget Sound have been of growing importance.

SHIPMENTS OF BLACK COD FROM ALASKA IN 1913.

Products.	Pounds.	Value.
Black cod:		
Fresh	14,308	$707
Frozen	5,436	327
Pickled	29,400	1,460
Total	49,144	2,494

FUR-SEAL SERVICE.

By Walter I. Lembkey, *Agent in Charge.*

Complying with instructions dated May 17, 1913, Assistant Agents James Judge and Ezra W. Clark left Washington May 18 for San Francisco, for the purpose of purchasing the annual supplies for the Pribilof Islands. The steamer *Homer* had already been chartered to transport the supplies to the islands, the charter price being $150 per day, including wages of crew. Owing to the limited appropriation provided by Congress, it was necessary to restrict the purchases to the actual necessities, such as food, clothing, fuel, and medical supplies. The amount of the purchases, all told, was $24,877.01.

The steamer *Homer* sailed from San Francisco June 23, arrived at St. George Island July 10, after stops at Dutch Harbor and Unalaska to discharge freight and take on coal. After discharging passengers, mail, and freight at St. George, the vessel sailed for St. Paul July 12, arriving next day. The return voyage to San Francisco, with sealskins and fox skins of the season's catch on board, was begun on August 8, arrival at San Francisco being made August 24.

AFFAIRS OF THE COMMUNITY.

NATIVES' BANK ACCOUNTS.

Since the management of the practical affairs on the Pribilof Islands was assumed by the Government in 1910, the agent in charge, namely, W. I. Lembkey, has acted as trustee for such natives as had sums of money for deposit as savings accounts. These accounts were placed on deposit in the Union Trust Co. of San Francisco, bearing 3½ per cent interest, and the interest was drawn by the trustee each spring and in turn paid over to the several natives having accounts.

Congress having abolished the position of agent, however, to take effect June 30, 1913, the trusteeship of the natives' savings accounts was, with agreement of all the natives except one, transferred to F. M. Chamberlain, naturalist on the Pribilof Islands, who succeeded to the administrative charge of all affairs of the islands. Drafts covering principal and interest on all the natives' accounts, with the pass book for each, were accordingly delivered to Mr. Chamberlain, and at his request were taken to San Francisco and deposited with the Union Trust Co.

Detailed records of all transactions in the fiscal affairs of the natives are filed in the Bureau of Fisheries in Washington.

CENSUS OF NATIVE INHABITANTS.

On St. Paul Island, the annual census taken June 30, 1913, showed 194 native residents, of which 94 were males and 100 females. During the year there were 7 births and 3 arrivals, also 1 departure and 9 deaths.

On St. George Island, the total native population June 30, 1913, was 110; 53 males and 57 females. During the year ending on the date mentioned, 5 births and 1 death occurred. There were no arrivals.

SUPPORT OF NATIVES.

Problems in Communistic System.

The instructions of the Bureau provide that the natives shall be supplied, so far as funds will permit, with the necessaries of life to an amount sufficient to maintain them in comfort, due regard being paid to economy and thrift. To this end, various supplies to be used by the natives, as fuel, food, clothing, etc., were purchased in San Francisco at the best wholesale rates obtainable and transported to the islands on the Bureau's chartered steamer *Homer*. These supplies upon arrival at the islands were placed in the two general stores (one on each island), where they were marked for issue or sale at a price one-third above wholesale cost, including all discounts except for cash. They were then distributed after the methods hereafter detailed. The increase of one-third over the wholesale cost was made to cover cost of transportation and handling only.

The instructions of the Bureau further provided that from the supplies thus taken to the islands merchandise to the amount of $40,000 be furnished the native inhabitants for their support and maintenance during the fiscal year ending June 30, 1913. These supplies were not to be received by the natives as a gratuity but as a return for services rendered. Services such as might be performed in the taking of sealskins and in the management of the herd in general were considered the main labor for which the natives were to receive this support; but, as the killing of seals was to be greatly curtailed, the natives, in return for their support by the Government, were to be required to perform such other labor of a nature to benefit the community generally as might become necessary or desirable. Individual natives, however, who were willing to perform such labor of a skilled or unskilled nature as might be necessary to the upkeep of the Government property and the maintenance of the stations in general were to be compensated individually in cash from funds other than the $40,000 set apart for the community support at the rate of, for skilled labor 25 cents an hour, and for unskilled 15 cents an hour. The skilled labor embraced that of carpenters, engineers,

painters, and ironworkers, etc.; the unskilled mere laboring work requiring no special aptitude.

The system involved in the foregoing arrangement for natives' support is one of almost pure communism. The main problem confronting those charged with its conduct was to support the people in such comfort and happiness as the resources would allow and at the same time to minimize those admitted evils of communal existence which, in this case, could easily result in reducing the island inhabitants to a mental condition of stolid apathy, and a physical condition of virtual peonage, if not slavery.

If no labor were required of these people, the problem would be simply to give gratuitously to each person supplies sufficient to insure his existence. It is necessary, however, at almost all times of the year to require some of them to perform services for which they receive no specific compensation, but merely a right to participate in the general fund. If all labor required of them were alike in character and amount and if all the natives could perform this labor with a like degree of proficiency, no special difficulty would be encountered. Some of the labor, however, requires aptitude and special training which some natives do not possess; also, some by reason of physical imperfections can perform less work even of a general nature than others, and some no work at all. To support the natives only to the extent that they perform service would be to allow some to suffer and others to starve because of inability to work and therefore to earn.

But if a helpless cripple and his family should not be allowed to starve, on the other hand a man of high efficiency should not be required to expend his best efforts for a compensation no greater than that which the cripple and his family receive for their bare maintenance in return for which they furnish no labor whatever, and which, too, the efficient would receive as a matter of course without rendering any service in return. Then, moreover, the fund for natives' support is not large enough to allow special compensation to some and general support to all, but sufficient only to prevent suffering no matter what labor may be required of them.

These and other questions, which perhaps appear trivial to the casual observer, become of vital importance to those managing the natives' affairs. It may be of interest to detail the methods which are used in the distribution of the fund for the support of the natives, all of which methods have been the subject of careful study.

The $10,000 fund was considered as belonging to the community and to be used for its support without regard to the question whether the person so supported was or was not able to perform service in return. It was therefore divided between the two islands on a strict per-capita basis; that is to say, the whole amount was divided into as

many parts as there were natives on both islands, and each island was allotted as many of these parts as there were natives on that island. From this fund before distribution, however, coal enough for both islands was paid for. This coal was turned over to the native community, and the community, through its chief men, was allowed to make distribution of it without official interference. No cash was paid from this fund except $1 a piece to each native man on Christmas and Easter, for church purposes, and a payment to a midwife of $5 for each baby born.

From the amount remaining after the deduction for coal, a suit of clothes was given to each man and boy; each individual was provided with two pairs of shoes; each family with material enough to make underclothing for the children and women, and each person with a supply of rubber footwear. From the remainder an "emergency fund" of perhaps $1,500 was set apart. What was left was available for purchase of food and clothing on regular issues. This remainder was divided into 52 equal parts, representing weeks in the year, thus fixing the amount that might be spent weekly for support of the whole population.

The total number of persons to be supported was next ascertained from the census—two children being considered as one adult and divided into the weekly allotment for the whole island, thus establishing a per-capita tentative allowance for each person per week.

The number of individuals in each family was then ascertained, and the per-capita amounts combined to give a basis for the expenditure for each family for the week.

It having been demonstrated that a large family under the same roof can live more cheaply per capita than a small one, a readjustment of amounts was made, deducting a certain sum from the large family allotments and adding it to those of small families. In this way a final adjustment of allotments was reached, giving about $5 weekly to a family of two, and about $7.50 weekly to a family of six or seven.

Having thus established the amount which each family may spend weekly, issues of food and such clothing as could be purchased out of the allowance were then made on Saturday of each week to the heads of families, each head being given an order for such supplies as he wished not exceeding his allowance, which order when taken to the store was filled, and the merchandise represented thereon given to the person presenting the order.

The emergency fund, already mentioned, was used to meet expenditures not contemplated in the regular allowance—such as occur in cases of death, sickness, marriage, childbirth, etc.

In this way the amount available for support of the natives is expended, not in cash, as stated, but in merchandise itself. The

amount is just about enough to support the population without want. It reaches a little more than $100 per capita. Everything to eat, to wear, and to keep the fires burning has to be transported over 2,000 miles, and the food is mostly in tins. Nothing edible except seal flesh can be obtained locally. It can be realized, therefore, that if the fund for natives' support is barely enough to provide the actual necessities of each person, little can be done toward encouraging and compensating extra effort or otherwise alleviating the objectionable features of communistic life in general.

Where a number of persons share equally in the distribution of a general fund, as these natives do, the natural tendency of each is to take and use the whole of that share without regard to whether it is needed or not. There is no inducement for a native to strive through self-denial to exist upon less than his share from the general fund when such abstention would result simply in increasing the share of his less provident neighbor. The whole tendency of a scheme of this character is to produce an attitude of carelessness in the use of communal resources—in short, to create that attitude of mind which says: "As there is no reward for economy, let's get all we can. The other fellow will get it if we don't."

Experimental Plan to Induce Thrift and Self-Reliance.

This tendency toward shiftlessness, which is an inevitable result of these peculiar circumstances, has long been recognized, and efforts have been made to palliate it at least. In 1911 a plan was put in operation designed to induce the natives to save at least a small portion of their earnings. It was based upon the general principle that by reducing weekly and other issues of supplies to a minimum an unexpended balance would be created, which balance at the year's end was to be distributed in cash among the earners according to their proficiency as workers. If even from a weekly allowance the native saved something, that saving was to be given him in cash at once. It was hoped he could be induced to open savings accounts with cash thus obtained, or at least to use it in purchasing some article not otherwise obtainable that would increase his happiness and comfort.

This scheme was placed in operation on St. George during the winter of 1911-12. The results from a careful following of the plan are interesting. At the end of the first month in which the native men were informed that such savings as they made from their weekly allowances for family supplies would be paid to them in cash, more than half the families in the village drew cash savings thus derived, the sums varying from $1 to as much as $8 or $9. They continued to do thus during each remaining month in the

year, almost every family saving something out of the amount allowed for its support.

Careful inquiries into the motives governing the making of these savings developed several interesting points. It seemed, on the whole, that the main object of the native was not to hoard the cash thus obtained by saving, but on the other hand, to get possession of the cash itself, which in many instances he at once took to the store to expend for perhaps the very articles he had denied himself in order to make the saving. Some few, of course, used the cash to purchase in San Francisco articles which could not have been issued to them had they not the cash. No savings accounts were created. If any sums were saved they were secreted in the natives' houses.

Some of the natives who made the largest savings had previously complained that their allowances were too small; those who have always been thrifty, however, redoubled their efforts to save, increasing their hoards regularly every month. But it was found that to make these monthly savings, in some cases the children in the family were made to suffer through deprivation of proper clothing and sometimes food.

At the end of the year, the sum of $632.48 was unused from the natives' fund and remained for distribution. This amount was divided among the sealers, the first-class men receiving about $32 each, and the lower grades in proportion. This money was nearly all spent in the store for articles of general use. No portion of it, as stated, was used to create or to increase savings accounts in bank. It is reported, however, that the natives were greatly pleased with the plan as operated and under it many of them came into possession of more money than they ever owned before.

The net result of this one year's experiment is not large. It shows that the natives desire their earnings in cash rather than a mere credit. It shows also that if paid in cash for their labor in taking sealskins, etc., the greater portion, if not nearly all of their money, would be used for the same purpose for which the credit is used, namely, the purchase of the necessaries of life. It shows that under the present communal system the natives are not desirous of creating permanent savings funds because of their inability to profit greatly by the result of the self-denial necessary to create the fund.

It must be stated that conditions were not favorable for carrying the operation of this plan beyond the mere point of inducing the natives to curtail their use of the necessaries of life to a minimum. It was impossible to demonstrate to them that any particular benefit would follow this saving, because there was nothing they might obtain with their savings except the bare necessities of life, of which they had deprived themselves in order to create the savings fund. And,

having saved, all they could buy was what they could have had without saving. Under the present system it is not permitted to purchase for island use anything but the barest necessaries of life. Articles from the use of which the average citizen finds enjoyment or benefit, and by means of which he is able to bring his life above the level of mere animal existence, are not allowed to be purchased for sale on the islands. Neither can the native improve his mind and broaden his education by travel, because no means of transportation are available. His clothing is of a certain fixed grade each year; if he desires a better suit or an unusual article of clothing, he can not purchase it because it is not in the store; nor can he order it unless through some cumbersome private arrangement almost impossible to make. In short, he is held down to the use of a greatly circumscribed class of merchandise, on an isolated spot of the universe, in which use he must live and die, practically without power to alter the condition.

Why, therefore, should the native save money? Money has no value unless it can be used as a medium of exchange. The mere hoarding of it induces no satisfaction or comfort to any normal person. The reward of self-denial exists in the possibilities for greater enjoyment and greater comfort created as the result of the self-discipline. If the native has no use for his money after saving it, he will not save it; neither will anyone. To carry out successfully any scheme of this character, it is necessary to broaden the possibilities of the natives' purchasing power. He must be able to buy desirable and attractive articles at least to the amount of his savings.

Everywhere, except to these people, a prize is offered for thrift. It should be held out to them, too. For example, it should be so arranged that the shiftless must wear poor clothing, but the provident may wear better. The provident, industrious man should be able to obtain better food than his careless and lazy neighbor. Under the present system, this is impossible. This situation could be adjusted readily by a private concern, and it should present no more difficulties to the Government.

Need for Broadened Opportunity.

Since the killing of seals has been stopped on the islands, except a few for food, and because of the material reduction in the appropriation by Congress for the natives' support, the system of cash payments has, unfortunately, been discontinued after only one year of trial. The building up of the moral and intellectual fiber of a people is a matter of generations, not of years, even under ideal conditions. In the case of these natives, not only should precept and example be afforded, but an intelligent readjustment of conditions on the islands should be made to give point and object to mere academic advice.

It may seem from the foregoing that because no greater results were obtained from this experiment, it is useless to attempt to lead the natives to greater self-reliance and thrift. It is believed, however, that such object is not so near an impossibility as supposed. The cause should be sought in the system, not the native. The instinct of self-preservation is as highly developed in these natives as in the more effete races, and this instinct forms the basis of all desire to lay by something of what is in hand to insure against future want. Under the present system the native expects that his future will be provided for, and has, therefore, no incentive to deny himself and no self-reliance. While no one would be willing to make the existence of these people a matter of doubt, on the other hand, it is thought that it can be so managed that the native would have to depend more upon himself, through the removal of certain of the paternalistic offices performed in his behalf by the Government.

As the situation is at present, the native merely has to work and to draw his weekly rations. He might complain in order to get more, but beyond that he has no voice in the disposition of his earnings. All the managing of his resources is done in his behalf by the agent in charge, under departmental instructions, and the only open line of endeavor is to hoodwink the agent into giving him more than his share. This unnatural situation should be remedied by allowing the natives more voice in the management of their domestic financial arrangements. It is believed, contrary to general opinion, that nearly all the native men are capable of handling their earnings in a thrifty and judicious manner, once they understand that it is necessary for them to do so or starve. Under this hypothesis it would be better for the native to receive his earnings, or at least a large portion of them, in cash at the close of each season with the understanding that this sum must suffice to support him and family for a year; or monthly amounts could be given them with the same understanding.

A native supervisory body should be created, the duty of which should be the oversight of the methods used by the several native men in handling their resources with a view of preventing suffering on the part of those children whose fathers might neglect to provide properly for them. This board should be chosen by the natives themselves, to be changed annually or at most every two years. The resident government representative should have general supervision over the whole, with power to enforce the findings of the board. Should a native be grossly improvident, a stated sum from his earnings should be set apart for use of his children. The Government should arrange to deposit any savings the native might make, or to expend them for such articles as the native may request to be ordered. At present this latter privilege is denied.

In short, the strongly paternalistic attitude of the Government, together with the communal system of living, has robbed these people

of all chance of self-improvement by destroying the incentive. Any effort along the lines indicated or others to increase this self-reliance will be salutary. It is conceived that a certain small percentage of receipts from the sale of skins taken by these people, set apart for them, either for their support or as a fund for the improvement of local conditions, or as a sheer bonus to increase efficiency and faithful cooperation, would be a paying investment.

Cash Payments for Sundry Labor.

What has been said in the foregoing concerning natives' earnings relates wholly to the fund earned by the community in general, mainly from the taking of skins. Such work as the natives perform as laborers or skilled workmen in maintaining the station buildings, exclusive of their own residences, is paid in cash monthly. These sums, although small, are welcome as representing the only cash the natives receive, and because this desultory labor is the only means through which the native may get individual results from independent action. Cash thus obtained almost invariably is used to augment the regular allowance of supplies, and the work through which it is obtained is eagerly sought. Not to pay them individually for such work, which is not at all for their benefit, would be to destroy the feature which removes their system of existence from mere peonage.

Accounts showing the character and value of merchandise issued to each native during the year ended June 30, 1913, as well as the amounts of cash paid to each for labor, with proper receipts, are on file with the Bureau, together with invoices, inventories, ledger accounts, balance sheets, and a statement of condition of business on the date mentioned. Cash slips showing character and amount of all cash sales of merchandise are also filed.

SANITATION AND HEALTH.

Importance of Studying Local Conditions.

As has long been known, the chief diseases of the natives of the Pribilof Islands are tuberculosis and related pulmonary troubles.

The importance of a careful study of the general question of health and sanitation on the islands was early realized, and the matter received serious consideration in March, 1909, shortly after the transfer of the fur-seal service to the Bureau. In the general instructions issued on March 31 of that year to the agent in charge this matter was presented in the following words:

> There is probably no other locality in America where questions of health and sanitation can be studied under such favorable conditions as at the seal islands. These islands are almost completely isolated from the rest of the world. The population is

quite definitely fixed; there is practically no immigration, no emigration, and little visiting with other communities. The islands constitute a compact physical and biological unit, a compact health or sanitary unit. The conditions are so isolated and so bunched as to render their control and study comparatively easy. This is true not only as regards the native animals and plants of the islands, but it is true also of the people who have long been resident on the islands. The conditions for scientific study of many problems relating to the health and well-being of the various species of plants and animals (including man) found on the islands are therefore peculiarly favorable.

As Mr. Chichester has been studying medicine for several years, many of these problems will doubtless appeal to him as questions in which he would be especially interested and which would afford him a fine opportunity for doing some excellent and valuable original work. His knowledge of the nature of disease, of bacteriology, hygiene, and sanitation will enable him readily to appreciate the exceptional opportunity and to formulate the details of the methods to be employed.

The Bureau therefore desires Mr. Chichester to take up the whole question of health on the seal islands and submits the following suggestions as to the scope and nature of the investigations which it wishes to have made:

HEALTH CONDITIONS ON THE SEAL ISLANDS.

Natives.—It is desired that a careful study be made of all the important conditions or factors bearing on the health of the natives. Many of the questions should be considered historically.

1. Housing: Character of houses as related to health; changes since first occupation, whether for the better or not; if present conditions are not what they should be, suggest improvements. Every house should be inspected with reference to sanitary conditions, including ventilation, light, heating, cleanliness, drainage, and general adaptability.

2. Clothing: In the past and now; whether suited to the climate, healthful, sanitary, adapted to the vocations of the people, etc.

3. Food: In the past and now; whether properly or adequately nutritious, and healthful; proper proportions of different kinds; properly prepared, etc.

4. Diseases: (*a*) Those brought to the islands by first colonists; which of these have disappeared and which have persisted; work out as fully as possible the history of each. (*b*) Diseases brought to the islands since the first colonization; when, whence, and by whom brought, and history of each since introduction. (*c*) Diseases induced by local conditions—i. e., originating on the islands or whose history can not be traced, if there be any such. (*d*) Diseases to which natives are peculiarly subject; the relative importance of the various diseases as shown by number of deaths from each and by frequency and duration. (*e*) History of therapeutics or methods of treatment of each disease by the resident physicians, together with consideration of results. If possible, compile mortality tables for all who have died on the islands since first occupation, giving name, sex, age, date of death, and cause. This bears upon (*d*). (*f*) Relation of climate and of habits and occupations of natives to disease. This should be carefully investigated. (*g*) A health card should be prepared for each person on the islands. This will supply the basis for thorough and continuous study of these questions.

5. Parasites: A special study should be made of the intestinal and other parasites affecting the natives, and ample study material should be preserved.

6. Use of intoxicants: The strong desire for intoxicants possessed by the natives is well known, and the necessity for protecting them against this desire is recognized.

The whole question should receive most thorough study and thoughtful consideration—the origin of the taste for intoxicants; whether this taste is growing stronger; whether the regulations now in force conduce to temperance among the natives and, if not, how they may be made more effective in that regard.

You are instructed to give this matter very careful consideration and to make such recommendations as will, in your opinion, be to the best interests of the natives and the service.

Dr. Harry D. Chichester, at that time one of the assistant fur-seal agents, and Dr. Walter L. Hahn, who was appointed naturalist in the fur-seal service in July, 1910, both heartily approved taking up this investigation and pursuing it in a comprehensive and thorough manner. They both believed it possible to free the islands completely of all infectious diseases and, through the maintenance of proper quarantine regulations, to maintain such freedom from disease.

As a preliminary requisite it was regarded as necessary to fill out a health card for each inhabitant of the islands, and, after conference with a number of able physicians and careful consideration, a suitable blank form was prepared by Dr. Chichester.

The matter was set forth again in definite instructions to the agent in charge July 27, 1910, from which the following extract may be made:

The betterment of the physical and moral condition of the natives is earnestly desired.

The service, for the study of these problems, is placed under the immediate direction of Dr. Chichester, who, under the general supervision of the naturalist, will organize the service with a view to securing the highest efficiency and speedy practical results. Attention is directed to office letter of March 31, 1909, in which is pointed out the exceptional opportunity which the islands offer for study of problems concerning public and individual health. The letter of March 31, 1909, is to be regarded as forming a part of these instructions.

All these problems should be taken up at once and their investigation pursued continuously and persistently to solution. With many of them important practical results should be easy of early attainment. Special and immediate attention should be given to those problems the study of which will lead promptly to results of real benefit to the natives. Among these may be mentioned the following:

Sanitary inspection of houses, water supply, etc.; directions and suggestions to natives regarding food, clothing, personal habits, etc.; physical examination and filling out of health card for each; determining and putting on record present conditions as a basis for future investigation. One problem which should be carefully studied is that of inbreeding. In small communities such as these, into which little new blood comes from the outside, there is sure to be too close inbreeding, with all the attendant evils. The blood relationship of the various natives should be made out as definitely as possible, particularly of man and wife. When close relationship is discovered, determine what evil effects, if any, on the children. Consider these questions in connection with the rules and practices of the church as to marriage. Consider also what can be done toward bringing new blood to the islands.

It is expected that the resident physicians will promptly and effectively cooperate in every way possible with Dr. Chichester and the naturalist in the study of these various problems.

It is desired that Dr. Chichester submit a full and detailed report to the Bureau next summer, showing what has been accomplished to date and indicating future work contemplated.

Both Dr. Hahn and Dr. Chichester died May 31, 1911, as a result of an accident on St. Paul Island, before they had been able to do

much more than enter upon this important work. Since that date various unexpected untoward conditions have arisen which have prevented any marked progress from being made in the study of these problems.

Health Reports.

The reports submitted by the physicians for the last year are brief; the more important matters contained therein are here given.

St. Paul Island.—During the fiscal year ended June 30, 1913, the resident physician treated 220 cases, not including subsequent treatments. These cases were varied in their nature, totaling about 46 different kinds. Several surgical operations were performed, including the removal of enlarged tubercular glands of the left axilla, setting fracture of the lower end of radius, incision of abscesses, etc.

Seven births took place during the year. There were 9 deaths, 6 of which were infants and 3 adults.

St. George Island.—The resident physician on St. George Island reports that there was very little sickness on that island during the year ending June 30, 1913, except an epidemic of influenza in the summer of 1912, when the whole population, including the whites, were attacked. Fortunately, with few exceptions, the cases were mild. During the winter the cases treated were chiefly gastro-intestinal and pulmonary affections.

Monthly inspections were made of the natives' houses and surroundings which, with few exceptions, were in excellent condition and creditable in every way. At the time of these inspections instructions were given to the natives on feeding and general care of infants and children, how to clean milk bottles, proper method of disposing of sputum and other excreta, the danger of expectorating on the floors, the value of fresh air, and the general principles of ventilation.

The records kept on this island show that there were 105 births and 94 deaths between January 1, 1891, and July 1, 1913. According to Dr. Mills, 70 per cent of the deaths have been from tubercular troubles, 25 per cent from gastro-intestinal disorders, and 5 per cent from other causes. At present about 25 per cent of the natives are suffering from tuberculosis in one form or another. The resident physician believes it possible to control this disease, with proper care and attention and the improved hygienic conditions of the last two or three years, together with an appreciation by the natives themselves of the necessity for properly disposing of sputum and other excreta.

The Bureau concurs in this view. It believes that a competent, resourceful physician in charge, ambitious to do something worth while, could in the course of a few years entirely free the island of tubercular and all other contagious and infectious diseases. This is a hope worthy of the ambition and best efforts of any physician. The

Bureau has on several occasions during the last three years, in its instructions to the agents and physicians, called attention to this matter. It is not without hope that this ambition may yet be realized.

NATIVE DWELLINGS.

The dwellings provided by the Government for the natives are, in most cases, tight, warm, and in fairly good repair. In four instances on St. George Island the houses are entirely too small for the families that occupy them. One family consists of husband, wife, and 6 children; another, of husband, wife, and 10 children; and two others each of husband, wife, and 7 children. The houses occupied by these large families have been enlarged by the addition of bedrooms built on the outside, but they are still too small. A number of larger houses should be built. The new buildings should be one and one-half stories, so that the upper floor could be used as bedrooms. The regulation house is one story, 12 feet front by 20 deep, divided into two rooms, with a lean-to on one side for a kitchen and an entrance.

The house occupied by the family of 12 is one of the largest and has a kitchen and three rooms, all of which are used as sleeping rooms. The largest room is 11 by 12 feet, the next 9 by 11, and the other 7 by 11 feet. To enlarge this house would be more expensive than to build a new one. One house, No. 8, said to be the oldest dwelling on St. George Island, became uninhabitable some time ago and has been torn down. All the lumber in it possessing any value has been used in repairing other houses.

The houses on St. Paul Island are essentially of the same type as those on St. George. Most of them are in fairly good condition, but many of them need considerable repairs, and some larger houses are needed.

New shingle roofs were put on one side of each of six native dwellings. Extensions of existing lean-to kitchens were made to two houses. The tenants, assisted by other natives, did the work without compensation. The Government furnished the material, and the work was well done.

UPKEEP OF RESERVATION.

It has been the policy of the agents to encourage the native men and boys in the use of common tools and the making of useful articles. On St. George Island during the past winter a number of such articles were made. Four pieces of office furniture were made by native workmen from plans or designs furnished them by the agent. These articles are a desk and cabinet, a typewriter desk, an office desk, and a cabinet around the safe, with card-index drawers.

For this work the natives received the usual wage of 25 cents an hour.

Telephone to Garden Cove.—The need of telephone connection with Garden Cove, on St. George, one of the three landing places on the island, about 2½ miles from the village, has long been felt. Last fall a small frame house 8 by 12 feet was set up there and telephone wire strung from it to the village. The lumber for the house was cut to length in the village shop and then carried on the backs of the men to Garden Cove and set up. Necessary telephone posts were obtained from the abandoned line to Staraya Artel. This work was done by the natives without compensation.

Zapadni watch house. The watch house at Zapadni was originally a sod house; that is, a frame structure banked up to the eaves with sod. The house was greatly in need of repairs; the roof leaked and much of the planking was rotten. It gave very little protection to the native guards, who live in it from June until November of each year. This spring a new shingle roof was put on, new studding put in the wall, and the whole building double weatherboarded after removing the former sod walls. The house is now tight and warm. The lumber for this work was cut to length in the village and hauled on sleds the 5 miles from the village to Zapadni. This was also "community work," i. e., work without compensation.

Wharf at village landing.—The old wharf was a light frame structure lashed to the rocks, forming the side of the landing slip. It had to be taken up each fall. Last fall a heavy sea carried the structure away. Instead of putting in a landing like the old one it was determined to build a large permanent landing, the fronts on the water to be of concrete and the whole thing filled in with huge bowlders that were piled on the end and at the rear of the former wharf. In prosecuting this work 40 barrels of Portland cement were used and 2,000 feet of lumber of various kinds, much of which was saved from the old wharf. The wharf as it now stands has a frontage on the landing slip of 40 feet, and running at right angles is another sea front of 40 feet, the two forming the water frontage of the landing. Over 2,000 square feet of wharf surface is secured, on which the bidarrahs can be handled and cargo landed. The former wharf afforded less than 500 square feet of available surface.

Over three weeks were required to complete this work. It is a solid structure of rock, faced with walls of reinforced concrete and will withstand the ice and sea and always be ready for use. The only expense was for material, the work being done by the natives without compensation.

Wharf derrick guys.—The galvanized-wire derrick guys had not been renewed for a number of years and were very rusty and stranded in many places. New guys of five-eighths inch galvanized wire were put on the derrick and on the boat davits, and new running gear also was placed in the latter. The whole equipment was worked over and put in the best of condition.

Wireless station.—The wireless station established on St. George during the summer of 1912 proved of great value. From September 11, 1912, to June 30, 1913, something over 200 official messages were sent and received. Many of these messages were from the Bureau and of the greatest importance. Without the wireless communication it is hard to see how the business of the station could have been conducted.

The only fault that can be found is that the sending apparatus is strong enough to send as far as St. Paul Island only. Three times every 24 hours the St. Paul Island wireless set is "tuned down" to hear St. George. At other times this set is unable to make itself heard at St. Paul. A great many things might occur between the regular calling hours that would be of vital importance to have known. For instance, a fire might start and threaten the entire village. Before the regular calling time arrived the plant might be destroyed, and it would then be impossible to make the condition known. Of course, nothing of this sort has ever happened, and every precaution is taken to prevent such a thing. But it is possible, and attention is called to the possibility in support of what is believed to be a need for a wireless sending plant that would enable this station to communicate with Unalga, where an operator "listens in" during the entire 24 hours.

WATER SUPPLY.

In the fall of 1912 a pumping system was installed jointly by the Bureau and the Navy Department for furnishing water for domestic purposes to St. Paul village as well as to the Navy wireless station. This proved of no service to the village, however, because the pipe supplied was of too small diameter to allow water to be pumped through it to the tanks. It was efficient only for the Navy wireless station, about halfway between the well and the village.

On October 9, 1912, or as soon as the 40,000-gallon reservoir tanks were installed on the village hill, an effort was made to pump water into them. After about one and one-fourth hours with a weak stream flowing into the tanks the pump, working at a pressure of nearly 200 pounds, smashed the teeth on two of its gear wheels and became useless. In response to a wireless message, the Navy authorities at Mare Island sent up to Nome additional gear wheels in time to have them there placed on the revenue cutter *Bear* and brought by her to St. Paul. Another attempt on November 12, at 180 pounds pressure, resulted in the breaking of a shaft in the pumping engine after an hour's work and further efforts to fill the tanks were abandoned. The pump broke because the strain necessary to force water through a pipe two-thirds of a mile long and 1¼ inch diameter to tanks with

an elevation of 100 feet above sea level was too great for the pumping engine to withstand. In addition to breaking its various parts while attempting to do this work, the packing around the pump was forced out from between the joints by the pressure.

To pump to the wireless station, a distance of about half a mile on a level, required much less pressure, and the pump was able to perform this duty practically at all times during the winter. Arrangements were made, therefore, to allow the natives to secure water from the wireless tanks at certain times daily, namely, between 9 and 10 a. m. and 3 to 4 p. m., thereby saving two-thirds of the distance the natives would have to travel in hauling water from the well itself as formerly. This arrangement after a trial seemed unsatisfactory to the natives, and after November 14 none of them applied for water at the wireless station. They objected to the arrangement because the water coming from the wireless tanks was greasy and was also cloudy from discoloration by coming into contact with the new redwood tank. The main reason for their dislike, however, seemed to be that they did not wish to adhere strictly to the hours set for them to get the water, but desired it at any time it might suit them to go. When they were refused this they went on to the well, pumped their own water, and hauled it home in casks on wheelbarrows or sleds, thereafter paying no attention to the supply in the wireless tanks.

To furnish an abundance of water to the village for domestic purposes is a matter of vital importance for the health of the inhabitants. Without it the houses can not be kept clean. When unclean, the filth furnishes breeding places for disease germs of all descriptions. The infants die in numbers from gastric disturbances because of the uncleanness of the vessels used in feeding them. The bed clothing in the squalid houses becomes filthy. Tuberculosis patients mingle with the healthy. The native is prone to be dirty by nature, but the doctrine of cleanliness can not be preached successfully unless water is furnished with which to put the theory into actual practice. The native simply can not furnish water enough to keep his dwelling clean when he has to haul it in casks on a wheelbarrow or a sledge a distance of nearly a mile. To do so would require his entire time and energy.

A determined effort should be made to install an efficient water system on St. Paul, whereby to bring to the native houses a sufficient supply of water for all purposes. The present system has ample well and reservoir facilities. A new pipe line only is required to replace that now installed, which is of too small diameter to allow water to be pumped through it to the distance required. The present pipe line is $1\frac{1}{4}$ inches in diameter. The new pipe should be at least

3 inches. A redwood pipe can be purchased in San Francisco that is more desirable and cheaper than metal.

In addition to this a satisfactory pumping engine should be furnished by the Bureau. The engine now there, furnished by the Navy, is of the cheapest construction (costing only about $130) and is constantly out of order. Furthermore, it can be operated only at the pleasure of the Navy employees. A system should be put in which would be entirely free of any supervision of the Navy authorities and under the entire control of the Bureau.

The natives will perform the labor without charge. The new pipe suggested would cost about $1,000; the engine about $500. It is earnestly recommended that this material be supplied, and Congress should be requested to appropriate the sum mentioned.

The fresh-water supply for the village on St. George is obtained from wells sunk in a depression a few hundred feet in the rear of the village. There are no springs. Water from melting snow and from rains is caught in the various ponds and gradually filters through to the sea, filling the wells as it runs through the low ground. The supply is abundant during the summer and during thaws in winter, but water is scarce in freezing weather. There are times when snow has to be melted by the natives to get water for domestic use.

To insure an adequate supply of fresh water, one or more large tanks should be installed. These tanks should have a total capacity of not less than 30,000 gallons. This would be sufficient not only to supply water for the village but also for freshening salted fox food, if that sort of food must be used. These tanks could be connected with the well, from which the water could be pumped into the tanks either by windmill or gasoline engine.

The cost of such a water-storage system would not exceed $500, exclusive of the labor incident to installation.

THE FUR-SEAL HERD.

The act of Congress approved August 24, 1912, provides, among other things, that "all killing of fur seals on the Pribilof Islands, or anywhere within the jurisdiction of the United States in Alaska, shall be suspended for a period of five years, and shall be, and is hereby, declared to be unlawful." The first sealing year under this law was that ending August 10, 1913. In strict compliance with this provision of law no seals were killed on either of the islands in the year ending August 10, 1913, except such as were necessary for food for the natives. The number was 2,298, of which 1,960 were taken on St. Paul and 338 on St. George. Two skins from St. George were not shipped, being too green to handle. This left 2,296 as the entire shipmsnt from both islands.

KILLING OF SEALS.

ST. PAUL ISLAND.

As the purpose of the killing this year was strictly for food for the native residents, no drives were made on St. Paul except from Reef Rookery, which is adjacent to the village, whither the animals could be driven and the flesh of the carcasses distributed to the various native families, or from Sea Lion Rock, whence the carcasses could be taken to the village in boats. During the year 125 seals were killed at North East Point to furnish fresh meat to sea-lion hunters, fox trappers, and guards at that place, but these were taken from isolated pods of bachelors without disturbing the large body on the hauling ground. The bachelors' hauling grounds at Zapadni, Tolstoi, and Halfway Point were not disturbed unless when visits were made to these rookeries for purposes of observation.

Details of the killings are shown in the following table:

STATISTICS OF KILLING ON ST. PAUL IN 1912–13.

Date.	Rookery	Number killed.	Date.	Rookery.	Number killed.
1912.			1913.		
Oct. 22	Reef	222	June 3	North East Point	10
Nov. 12	do	184	9	Reef	154
Dec. 1	North East Point	58	23	do	335
10	Sea Lion Rock	67	July 3	do	44
23	do	130	7	do	414
1913.			8	North East Point	15
May 14	North East Point	12	22	do	3
21	Sea Lion Rock	132	Aug. 1	Reef	153
21	Nort East Point	5	6	North East Point	3
24	do	19		Total	1,960

ST. GEORGE ISLAND.

Within the sealing year ending August 10, 1913, 8 seal drives were made on St. George Island, from which a total of 326 seals were killed. Within the same period the native guards at Zapadni killed 12 seals for food, making a total of 338 for the year. Of this number, 336 skins were shipped on the *Homer* August 8, 1913. Two skins, taken August 5 by guards at Zapadni, being too green to bundle, were held over until next year.

STATISTICS OF KILLING ON ST. GEORGE IN 1912–13.

Date.	Rookery.	Number killed.	Date.	Rookery.	Number killed.
1912.			1913.		
Oct. 23	North Rookery	40	June 23	North Rookery	38
23	Zapadni guards	2	29	Zapadni guards	2
24	do	1	July 3	North Rookery	44
Nov. 5	North Rookery	18	5	Zapadni guards	1
11	Staraya Artel	5	9	do	2
22	East Rookery	37	20	East Rookery	85
1913.			Aug. 5	Zapadni guards	2
June 10	do	59		Total	338
17	Zapadni guards	2			

RETURN OF YEARLING SEALS.

The determination exactly of the date of return of yearling seals to the islands after their first migration has been relatively unimportant until recently, when charges were made in Congress that the yearling seals have formed the bulk of the annual takes of skins, and that among these yearlings so claimed to have been taken were thousands of female yearlings the sex of which, because of their extreme youth, it was impossible to recognize until after death. All the natives and all the white people who have ever been engaged in the taking of sealskins have held that these yearlings never appear in any considerable numbers on the islands until after the 1st of August, after the annual catch has been secured, and that when so appearing they are so small that their skins are undesirable. This belief, however, has been based wholly on general observation and experience which, although thoroughly reliable as such, was not the result of such extended scientific investigation as would be regarded as a complete demonstration of the fact.

To obtain exact knowledge as to when the yearlings really arrive, and their size and weight at the time of arrival, has been the endeavor of the Bureau for the last two years. To this end, the Bureau's instructions in 1912 required that a large number of seal pups of that year be permanently marked with a hot iron brand on the head. When these animals so marked appeared the year following, no question as to their identity as yearlings could be raised, and observation of them would afford exact data as to their movements as well as to their weight and size.

Following the Bureau's instructions, 5,529 pups of both sexes were branded in 1912 with a permanent brand. As these pups of 1912 would be yearlings in 1913 a careful watch was kept for their return in the latter year. In all drives made in 1913, every pod of seals driven up was carefully scrutinized to determine whether any of these marked yearlings were present.

In the drive of June 9, on St. Paul Island, no branded yearlings were seen, nor any seal, in fact, small enough to approach the size of a yearling, according to the usual acceptation of its size. On June 23, no branded yearling was seen and only seven small seals that might be classed as yearlings, although their identification was in doubt.

On July 7, none of the branded yearlings appeared, and very few small seals.

On July 24, no branded yearlings having yet been found, the hauling ground on Reef rookery was driven, in order to discover how many if any, of these marked animals were present. The seals were separated into pods, of perhaps 50 animals each, and each pod was carefully examined in turn to ascertain how many of the marked yearlings might be in it.

Out of the entire drive of more than 1,200 seals, 6 marked yearlings were found, and all of them were males. Although only 6 of those marked were found, there were present a few other animals of similar size which might properly be classed as yearlings, but the whole number of this size present, including those not marked, would not equal 10 per cent of the whole number in the drive. None of the marked seals was killed.

A single yearling appeared in the drive of July 20 on St. George.[a]

ARRIVAL OF SEALS ON ST. GEORGE ISLAND.

The first bulls to haul out this season appeared May 8 on North and East rookeries. The first cow appeared on North rookery, June 12. Details of certain observations on the arrival of seals and harem counts are given in the following table:

COUNT OF BULLS, HAREMS, AND COWS, ST. GEORGE ISLAND, NORTH ROOKERY, SEASON 1913.

Date.	Bulls.	Harems.	Cows.	Idle bulls.	Quitters.	Remarks.
May 8	4	.....	.....	.....	1	
18	30	.....	.....	.....	1	
21	47	.....	.....	.....	5	
24	58	.....	.....	.....	5	
29	60	.....	.....	.....	6	1 bull in water.
June 5	64	.....	.....	.....	3	15 bachelors.
7	76	.....	.....	.....	2	
12	80	1	1	79	10	40 bachelors.
16	82	1	1	81	5	
30	99	69	924	30	14	
July 2	99	75	986	24	4	
3	99	77	1,016	22	10	
7	104	95	2,214	9	5	

After the early days of June, when the seals had hauled out in numbers, no complete counts of the nonbreeding seals were made by the agent. The full census of all classes was made by Mr. George A. Clark, special investigator, who will make a separate report.

SEAL MEAT NECESSARY FOR NATIVES' FOOD.

The natives are almost entirely dependent on seals for fresh meat. For both islands at least 5,000 carcasses from seals of desirable ages should be provided to afford the natives an abundance of the food which has formed the basis of their diet.

In addition to the number of seals killed for natives' food, a sufficient number of carcasses should be put in the silos during the summer to provide fox food from September 15 to the following May. Between these dates birds are not sufficiently abundant to supply the

[a] A telegram dated March 16, 1914, from Mr. P. R. E. Hatton, in charge on St. Paul Island, reports a total return of 14 branded seals to that island in 1913 between July 14 and November 8. On St. George Island a total of 74 branded seals were seen, chiefly in drives between August 16 and November 25. This is a total of 88 for the two islands, out of the 5,529 branded pups of 1912. They were never seen in numbers, but appeared occasionally on a number of different rookeries.

foxes with enough food to keep them from starving. Previous to 1904, the number of seals killed each fall, whose carcasses were allowed to remain on the ground, provided ample food for the foxes, but as the killings decreased this food gradually became less and less, until it became necessary to preserve food in silos to carry the fox herd through the winter. At that time the lessee was required to furnish each year 12 tons of dried or salted fish, in addition to the seal carcasses preserved. Last year the fox herd on St. George alone consumed 12 tons of salted whale meat and 10½ tons of salt salmon, in addition to what they could get from the refuse parts of the carcasses left on the killing grounds and the birds, fish, and other food they could get by hunting and combing the beaches. The salted food was put out at the fox trap and none was wasted. In the absence of this food the foxes will starve to death.

THE FOX HERD.

ST. PAUL ISLAND.

Fox trapping was allowed on St. Paul Island for a period of six days, from December 2 to 7, 1912, as the result of which 143 blue and 30 white fox skins were secured. These were shipped in tight casks on the *Homer* to San Francisco and there consigned by freight to Funsten Bros. & Co., St. Louis, as directed by the Department.

The two localities on St. Paul in which foxes are most numerous are those in which the greatest number of seals have been killed. These are North East Point and the village. The fox-trapping locality next in importance is Southwest Bay, which contains the Zapadni rookeries and killing ground. Foxes are least numerous where seals are not present at all and where the foxes exist on birds, beach food, and various vegetable matter.

No reliable method of ascertaining the number of foxes remaining on St. Paul at the close of the trapping can be used. That many survived the trapping season, however, is known. From those actually observed and from the fox tracks seen in the snow it could almost be believed that the trapping made no appreciable impression upon the number in the whole herd. The following summer (1913) foxes, both young and old, could be seen anywhere in plenty and, if anything, more numerous than before.

The St. Paul foxes seemed to be in no lack of food during the past winter. With one exception all foxes taken at the village were well supplied with fat, and that animal was suffering from severe ulcers on the stomach—outside lining. Nearly all had full stomachs when captured. The winter, however, was unusually mild and open, with little snow, giving the foxes exceptional opportunity to forage, which they would not enjoy under usual winter conditions.

In the summer of 1912 a pit at the village was filled with seal viscera and the bodies of such few seals as were for any reason objectionable for natives' food. In February following this pit was opened and some of its contents strewn about. Thereafter the foxes frequented this hole, eating of the contents. No salt or other preservative was used on the contents of this pit.

A reindeer died at the village on February 2, and the body was consumed by foxes in several days. The two deer dying at North Shore were also eaten almost immediately. Those deer dying in the corral at the village were eaten by foxes almost before the bodies could be found by the herders. This consumption of fresh meat in such short time by the St. Paul foxes is unusual, and indicates not so much a scarcity of food as an unusually large number of foxes.

As the fall of 1912 was the first in which there was complete absence on the rookeries of the bodies of seal pups dead from starvation because of the mothers being killed at sea, it was a matter of interest to observe how the elimination of this accustomed food supply would affect the foxes. It could not be seen that foxes were suffering from lack of food at any time, but it is believed that the unusual openness of the winter compensated in great part for the absence of dead pups. Had the winter been severe and the beaches piled high with the usual ice barricade (which was wholly absent last winter) the foxes undoubtedly would have suffered from lack of food.

ST. GEORGE ISLAND.

On St. George Island fox trapping began on the night of November 26 and ended on January 31. The village trap was used 21 nights and string traps were used in the village three days. At Zapadni trapping was carried on two days and only one fox was caught.

The first night of trapping at the village 247 foxes passed through the fox-house trap; the second night 76, the third, 85, and the fourth, 64. Thereafter the number varied from night to night, but never equaled the numbers of the first four nights. The total number of foxes killed was 268, of which only 1 was white. Five of these skins were mangy, and 15 other mangy skins were taken from foxes found dead, making 20 mangy skins in all, which were shipped to the Bureau for examination. The skins in good condition numbered 263, including 1 white.

Trapping can not be carried on successfully every night. Those branded and released will return to feed, but soon become "trap-shy" and will not reenter the trap, although all sorts of devices are resorted to to induce them to do so; there is always a number that will return and feed, but will not enter the trap.

Selective breeding and the food question.—The present foxing methods on St. George Island were put in practice about 1897. The method

was based on the theory or belief that by killing the poorer foxes and reserving the better conditioned ones as breeders a superior strain or breed of foxes could be developed. Proceeding on this assumption, those to be reserved as breeders were branded and released. During recent years the number so branded and reserved has usually been about 200 pairs annually, and all inferior animals were killed. No discoverable improvement, however, has been noted. The catch of the winter of 1912–13 was of poorer quality than that of the two previous years, and more mangy foxes were killed last year than in any previous year.

The causes of the deterioration are evident. The natural food on St. George Island obtainable by the foxes is not sufficient for their needs. Until in recent years the numbers of seals killed on the island each year, the refuse parts of the carcasses of which were available for fox food, were sufficient, together with other obtainable kinds of natural food, to supply the foxes adequately and with wholesome food. But during the last few years the amount of seal meat has not been enough for their needs. Therefore, from about the first of October until in May the foxes, finding little or nothing else to eat, have been fed mainly on salted food freshened in sea water. Meat sufficiently impregnated with salt to preserve it, then freshened in sea water, can not come from the freshening vats with any less salt than is contained in the water in which it has been soaked. A diet carrying that much salt, fed to foxes year after year during seven months, can not be wholesome and must inevitably produce injurious results.

Furthermore, the trapping season extended over too long a period. It should be limited to a week or 10 days, as it was on St. Paul. The period during which the fur is at its best is very short.

A quantity of whale flesh (12 tons) was shipped last August from the whaling station at Akutan to St. George to be used for fox food, to compensate for the absence of the usual amount of seal meat saved and stored for that purpose. When this whale meat was fed to the animals during the winter they ate it with eagerness and seemed to enjoy it more than any other food that has been given to them heretofore, not excepting the dried salmon which the lessee used to furnish. In 1913, unfortunately, this whale meat could not be obtained, because the Akutan whaling station was closed. As the foxes had to be fed, attempts were made to induce natives of Unalaska to catch fish for this purpose, and one native responded by proposing to catch any amount of Attu mackerel or kelpfish, dried, up to 10 tons, at English Bay, Unalaska Island, at $20 a ton, the Government to furnish the sacks in which it was to be shipped. As no other offer was made, the proposition of the native was accepted. The live fish were there in quantity, but after catch-

ing about 5 tons and hanging the fish up to dry, most of it spoiled because the weather was too rainy to permit of drying. As the matter was urgent, Agent Lembkey visited the place, to induce the man to renew his efforts. He also procured a quantity of burlap for shipment of the fish and arranged with the Revenue Cutter Service to transport it from English Bay to St. George some time during the fall. It is not known what quantity of this fish was furnished.

On St. Paul, realizing that the St. George foxes would be in danger of starvation during the winter of 1913–14, on July 7 such pieces of seal meat as were left on the field by the natives and such few seal carcasses as were undesirable for natives' food because of the removal of the blubber, were hauled to the village and there cut up and barreled after being lightly salted. Twenty-four barrels were so filled and sent to St. George on the *Homer*. This quantity of seal meat would weigh about 2½ tons and will last only a short time.

REINDEER HERD.

On the last day of August, 1911, 4 male and 21 female adult reindeer were placed on St. Paul Island, and on the next day 1 adult male, 12 adult females, and 2 young males were landed on St. George Island by the revenue cutter *Bear*. These reindeer had been supplied to the Department of Commerce by the Department of the Interior from its herd at Unalakleet, on the mainland.

Up to the spring of 1912, the losses had been but 3—1 male and 1 young cow on St. Paul and the adult bull on St. George. In the spring of 1912 there were produced 17 healthy fawns on St. Paul and 11 on St. George. At the end of August, 1912, there were on St. Paul 3 adult bulls, 20 adult cows, and 17 young, or a herd of 40. On St. George there were 2 adult bulls, 12 adult cows, and 11 young, or a herd of 25; a total of 65 on the two islands. The losses from these until September, 1913, on St. Paul were 1 adult bull, 1 adult cow, 1 yearling cow, and 2 yearling bulls; those on St. George, 1 adult bull, or a total of 6.

In the spring of 1913 there were produced 18 healthy fawns on St. Paul and 13 on St. George. At the end of September, 1913, the herds therefore consisted of 2 adult bulls, 18 adult cows, 7 yearling bulls, 7 yearling cows, and 18 fawns on St. Paul, or a herd of 52; and on St. George 2 adult bulls, 12 adult cows, 2 yearling bulls, 9 yearling cows, 8 male fawns, and 5 female fawns, or 36. The total for both islands at the end of September, 1913, is therefore 88. This is a net increase of 120 per cent in the two years.

The experience of the two years has demonstrated the practicability of maintaining a reindeer herd on each of the islands. The climatic conditions are favorable, or at least not unfavorable. There

was no loss that could be attributed to the physical environment. The agent and others familiar with St. Paul Island believe that the reindeer moss and other suitable food are sufficiently abundant on that island to support a herd of at least 1,000. The moss on St. George Island is thin and short and will probably not support a herd of more than 150 to 200.

The herds appear to require no special care except in the spring, when the young are being dropped. Experience has shown that, unless cared for, the young are apt to wander away and into holes or crevices in the rocks from which they can not extricate themselves. It has been found advisable to corral the does and to give them constant attention during the period when the young are being dropped and until the fawns are well able to take care of themselves.

The St. Paul herd has been under the direction of two native herders, each receiving as compensation for his services the sum of $2.50 a month. These herders twice each week search for the herd, which wanders at large, and drive it slowly to a point near the village in order to accustom it to man's presence and to being handled.

On January 30 last a young male was found injured in the hind leg, which dragged inert as the animal walked. The deer was driven slowly to near the village and an examination made, which showed the knee and hip joints to be greatly swollen and stiffened. On the suggestion of Dr. McGovern the animal was placed on a sled and brought to the shop, where it was intended to place it in a sling and, after clipping the affected areas, to apply thereto an ichthyol and iodine dressing. While this was being done, however, the animal quietly died. An autopsy showed both the joints mentioned to have been torn asunder by some violent strain, conjecturably through fighting with an older male.

On March 15, 1912, a yearling female was seen to be somewhat disabled in a fore leg, but keeping well up with the herd. On the 22d, however, the body of this animal was found at North Shore nearly eaten by foxes, not enough being left to determine the cause of death.

On April 28 a doe was found to have died in giving birth to a still-born fawn.

On May 5 two fawns were born dead. On the 18th a two days' old fawn was found dead in a small hole in the corral and almost entirely eaten by foxes. On the same night a female yearling died in giving birth to her fawn, and by morning both bodies were almost entirely eaten by foxes. On the 28th the body of an old male, of the original stock, was found at North Shore.

The herders reported the deaths, therefore, of 1 old female, 1 old male, 2 yearling females, 1 yearling male, and 5 fawns.

The herd habitually resorted to an area near North Shore almost 10 miles away from the village and nearly inaccessible in winter.

For this reason it was not possible to ascertain the date of the rutting season without a man's staying continuously with the herd, which was impossible, as no houses were in the vicinity. The season for dropping fawns, however, begins between April 1 and 15. The habit of the female when approaching delivery is to absent herself from the herd and seclude herself in some chosen spot where her young is born. To keep the females under observation during this period, and to prevent the new-born fawns from straying into holes from which they could not extricate themselves, the whole herd, was on March 22, driven into a corral about a mile from the village, where it could be visited daily. As the moss in this corral is sparse, it became necessary for the herders each day to drive the animals outside, allow them to graze for several hours, and then return them to the corral. When the first fawn was born the herders kept the animals inside the corral and gathered moss outside which they carried to the animals.

On April 17 the deer broke through the corral fence and escaped. When finally driven back four females were missing and remained at large until several months later, when each was found with a living fawn. Whether it is desirable to confine the animals in this restricted inclosure during the fawn-dropping period, or whether to allow the does to follow their desire to isolate themselves at this time, is conjectural. The does on St. George have not been confined in inclosures during the period of parturition, notwithstanding which no seeming increase in the death rate resulted.

There are not yet enough animals in the reindeer herd to allow of killing any for food or of training any to draw vehicles. Females should never be killed, of course. In the case of males, selective killing should be practiced; i. e., only the smaller and less vigorous males should be used for food. The Esquimo herders saw off the horns of the most belligerent bucks, that the latter may not injure the younger males. Observations show that the species has much less resistance than a wild animal would be supposed to have. Of the two adults found last winter with injured legs, both died, although the injury of itself was not fatal, and did not prevent the animal from obtaining as much food as it desired. Innumerable instances can be cited of cattle, horses, sheep, and foxes living for years after an injury that partially or wholly destroyed the use of a leg. From this it may be deduced that, as draft animals, the reindeer would be of much less utility than a horse or mule. If trained, however, it probably could travel with a light load over frozen surfaces with facility. Its greatest use to the Pribilofs will be that of furnishing fresh meat for human consumption, refuse meat for the foxes, and skins, which make superior sleeping bags.

No possible interference with seals or foxes can occur on the part of the reindeer. At best it is a timid creature, except perhaps in the

rutting season. The herds invariably frequent the uplands in the interior of the islands, miles from the nearest seal rookery. When driven to the village and there released, the herd at once travels back rapidly to the interior. On St. Paul, the mules while grazing find sport in stampeding the herd, if it approaches, and chasing it until the mules tire. The reindeer and seals have never been seen together, but it is almost certain that the latter would be not in the least disturbed by the deer.

At present the reindeer in the herds on the Pribilofs are the property of the Government. Native herders are employed, two on each island at the nominal salary of $2.50 per month each, to look after the herds and give them such attention as they may need. No reindeer have yet been killed for food. It is the intention to begin killing whenever the number of males considerably exceeds the needs of the herd for breeding purposes. After reserving the number of bulls necessary as breeders, the useless males will be killed for food and their skins. The conditions under which this food will be furnished to the natives have not been definitely determined.

It has been suggested that a system of apprenticeships be established whereby the natives may acquire individual ownership in the deer. Such a system has a number of advantages. It would, it is believed, cause the natives to take a greater interest in the deer and be more active in their care.

The natives would acquire the stimulus that comes with personal ownership and the possibility of personal profit from the sale of meat and hides.

There is no reason why the reindeer may not be utilized to a considerable extent on the Pribilofs in connection with travel and transportation to and from the remoter parts of the islands. The natives should be taught reindeer driving, not only for utilitarian reasons but because of the pleasure to be derived from sleighing parties during the long seasons of snow.

The same danger of deterioration of stock as a result of inbreeding will be encountered here as with domestic stock anywhere. To avoid this danger and for the purpose of general improvement of the herds, it is recommended that reindeer from the Alaska peninsula be introduced from time to time.

SEA LIONS.

The small herd of Steller's sea lions on St. Paul and the much smaller one on St. George seem to remain without either increase or decrease. These animals would not be disturbed at all by the islanders were it not for the fact that the skins of the surplus males have been and are still used for covering the native bidarras or large lighters essential for transporting cargo from the supply vessels to

the beach. No other form of boat, carrying the same quantity of merchandise, is light enough to be handled by the force of workmen on the islands. It has been the practice, therefore, to secure on St. Paul skins enough to renew each year the cover of a bidarra on each island. The St. George herd rarely if ever furnishes a skin.

In late years it has not been possible to obtain such a number of skins. No drive of sea lions on St. Paul has been made since 1909, notwithstanding annual attempts to make such drive.

The driving of sea lions requires skill, patience, and courage that not all the native hunters seem to possess, and does actually call into use all the aboriginal skill in hunting that these men have fallen heir to.

The animals sought to be secured are the immature males and young male adults that have not been able to secure cows. These, as do the fur-seals of the same class, gather in one place usually, apart from the breeders. They are enormous beasts, 10 to 12 feet long, each weighing nearly or quite a ton. They are very wary and will rush for the water at sight, sound or scent of any disturbing element.

It is the object of the native hunters to place themselves between the sea lions and the beach and to induce them to run inland instead of into the water. Once started in an inland direction they may be driven slowly but with comparative ease to any place where it is desired to kill them.

To get between the animals and the sea is the difficult and dangerous task. The wind must be directly off shore or slightly quartering, or otherwise the scent of the approaching hunters would cause the creatures to rush into the sea before they could be intercepted. If the beach line is clear and the wind favorable, the men creep carefully along the rocky beach at low tide until they have reached a position favorable for turning the sleeping animals inland. Then rising suddenly with shouts, hand clapping, and gunshots the attempt is made.

If all goes well, some of the animals in their fright will rush inland; others will make for the water despite the noise. Then it is well if a luckless native is not in the line of a charging beast, as nothing can stop it until the sea is gained. Many narrow escapes from injury or death from trampling or a snatch from the enormous jaws has served to add zest to the enterprise.

If a drive is made, the animals are driven to a level stretch of ground where racks have been erected. There the beasts are shot, the skins removed and piled one over the other, where, covered with grass or turf, they are allowed to "sweat" until incipient putrefaction has so loosened the hair that it can be scraped off. The skins then are taken up, scraped clean of hair, and stretched on the racks until

they become dry and stiff. In this condition they are stored until time to use them for a boat cover. Then they are soaked until soft, the edges trimmed until they fit each other, and are sewed together by the women with thread made of whale sinew, or better, as has been found, with stout linen thread. The cover while wet is stretched taut over the boat frame, lashed to the gunwale with heavy twine, and allowed to dry. When dry it is as tight as a drumhead and as stiff as sole leather. Since 1909 conditions have not been propitious for making a drive of these animals. While they have been present each year, either they haul out in places inaccessible for driving, or the weather conditions were not favorable for the men to approach without giving alarm. Attempts each year to make a drive have been without success.

This spring (1913) the usual report came from North East Point that about 50 sea-lion bachelors had hauled quite a distance back from the beach and that a drive probably could be made. Acting on this, on May 14, a team was sent with eight hunters and a cook. On May 20 these men were brought back after they had made several unsuccessful attempts to secure the drive. On May 23 the party again was sent out and remained until the 31st, when further attempts to make the drive were abandoned.

During this whole period the wind was favorable for driving on only two occasions, May 20 and 24. On the first date a drive was attempted. As the animals lay widely scattered, the driving gang was divided into two sections, each approaching along the beach from a different flank upon the center. While crawling along the water's edge, before they were in position to rise suddenly and startle the animals a fox in the driver's path ran off among the sea lions, barking at the men. This caused the drive to withdraw to the beach, and made the attempt a failure. On the 24th the sea lions were so widely scattered that none could be prevented from plunging into the water.

While it is necessary to have these boat covers made of some flexible material, it is believed that heavy canvas could be substituted for sea-lion skins and used to advantage. This could be sewed as are the skins, and covered with paint or oil. The dislike of the natives to use a bidarra covered with anything else than sea-lion hides would have to be overcome. Certainly the bidarras now on the islands will have to be covered with something soon, and, as no skins seem to be obtainable, something else will have to be used.

Sea lions are plentiful on Bogaslov Island, west of Unalaska. The natives of St. Paul found over 100 young males on Walrus Island June 14 of this year. The species is not in danger of extermination, but conditions seem to prevent any from being captured. It is not allowed to shoot them on their breeding grounds.

WALRUS ISLAND BIRD RESERVATION.

Walrus Island, a low-lying islet about one-third of a mile long, lies about 8 miles east of St. Paul Island. It is barely above the wash of the surf at its highest point, and is composed mainly of lava layers breaking abruptly into the sea. Basaltic bowlders form a small portion of its north shore line. About 1,500 square feet of its surface is covered with loam; the remaining surface is flat, rain-washed rock or loosely strewn bowlders.

In previous years a few walrus hauled out here, and perhaps a few lived here, but from the small area and general topography of the place it can well be assumed that it must have served merely as a hauling or resting ground for young or surplus male walrus, the overflow from the main walrus rookery on North East Point on St. Paul. From the presence of these few walrus in former times, however, the islet got its name. None of this species has been seen to land here since about 1890.

This small island, however, has long been known as the breeding place of countless thousands of a few species of sea fowl. So great is the profusion of bird life there that this little rock is generally known as one of the few remaining places in the world where wild life may still be found in such superabundance as to be innumerable and startling.

Positive efforts to conserve this bird life have never been made. The inaccessibility of the locality has rendered it immune from disturbance by man, if we except the annual visits of the St. Paul natives to gather eggs. On these visits the native party would gather a boatload of eggs of the murre, which are laid on the flat bare rock without sign of a nest. If the weather is favorable, this trip may be followed up perhaps by a return visit a week afterwards, when the surface previously gathered over is again covered with eggs unmistakably fresh.

Walrus Island was made a special Government reservation in 1909, but the privilege of the natives of St. Paul to visit this island during the spring to collect eggs for food, as has been their custom for years, has been continued. Of such visits in the summer of 1913 it is purposed to report here.

On June 12, 1913, a rowboat manned by six natives left St. Paul village about 5.30 a. m. and visited Walrus Island, returning about 5 p. m. with about 1,000 murre or "arrie" eggs. These were gathered off the flat top of the island without necessity of selection, as all were fresh. The boat captain stated that only a small space on the island was cleared of eggs, as more could not be brought back in the boat with safety to the crew. He reported that many gulls were to be seen there, but the crew could not find over a dozen gulls' eggs. This is quite an unusual circumstance as the gulls usually lay their eggs

before the murres. Bird life in general was reported to be as plentiful as heretofore.

An opportunity to visit the island again did not occur until June 30, when Mr. Kleinschmidt, charterer of the schooner *P. J. Abler* lying off St. Paul island, made the trip to Walrus Island in the schooner and kindly took Agent Lembkey along, together with five natives to gather some more eggs, if the condition of the latter would justify gathering for food. Several hours were spent there, and opportunity was afforded for a somewhat careful observation of conditions.

The area denuded of murre eggs by the native party on June 12 was found completely covered again with eggs, which however, were already incubated to a point rendering nearly all of them undesirable for food. Only about a bushel of eggs was taken by the natives, each egg having been tested in water and found to sink.

At this date no murre chicks had been hatched. Of the glaucous winged gulls, only three chicks were found, two perhaps a week old and one just out of the shell. The young cormorants, very few in number, had grown to over half the size of the parents, but were still in down and had scarcely any feathers. No puffin young were found, but many puffins were seen hatching in their burrows and several of their eggs when broken were found to be about one-third incubated.

No diminution in the numbers of birds frequenting Walrus Island seems to have occurred. As the boat containing the visitors approached the landing, all cliff edges were seen to be alive with murres, standing so close together as almost to be touching each other. They paid but little attention to the visitors even after the latter landed, and retreated only a few yards from the person coming toward them. Even within this, they constantly returned, each to straddle its particular egg lying precariously on the flat rocks without sign of nest, and sometimes rolling its own or other eggs about in a way that demonstrated the unusual thickness of the shell. With all this rough treatment and confusion very few eggs were broken. The murre eggs covered thickly all the flat space usually occupied by them and few if any more could find hatching space.

The glaucous-winged gulls arose in clouds as the party moved about the island, and were continually rising and alighting again, as were the murres. A few kittiwakes were seen nesting on the abrupt faces of the cliffs in the little shelving recesses which they frequent. With the exception of the small bowlder beach on the north side no areas were found that could have been used for breeding purposes, and here it is possible that in a storm the space might come within the reach of dashing spray and therefore be undesirable. It is fair from this to conclude that bird life on this island is probably at its greatest expansion. It certainly is as profuse to the eye as when it was

visited by Agent Lembkey in 1899. During the time of the visit on June 30 last the air was so filled with flying birds that photographic plates with a very short exposure showed them as thick as flies over the whole sky space on the film. In short, the number of birds in the air was as remarkable as the very remarkable number of birds on shore. The impression that the whole scene creates upon an observer is that there are millions of birds inhabiting this little island. When it is considered, furthermore, that the islands of St. Paul and St. George, especially on those portions of shore line where abrupt cliffs are found inaccessible to man, contain breeding areas for these same species many times greater in extent than the whole of Walrus Island, some faint idea can be gathered of the boundless profusion of bird life about the islands.

It does not seem that the destruction of eggs by the egging expeditions of the St. Paul Island natives ever has had the effect of diminishing the birth rate. The eggs most sought and generally obtained are those of the murre. This species will lay and hatch but one egg if undisturbed, but experiments made on several occasions show that if the first be removed the bird will immediately lay another and a third if the second be removed. In some cases, even a fourth egg will be laid if the previous ones have been taken away, but the fourth usually is small and seems to mark the limit of the bird's endurance. The natives never remove eggs from any specific breeding area more than twice in one season, and all such eggs when removed appear to be immediately replaced by the birds. It would seem that this could have no effect upon the numbers of birds hatched but merely would make the date of hatching somewhat later, a matter which would work no particular loss of offspring.

It is likely that in a state of nature many murre eggs are destroyed and have to be replaced. The eggs are laid usually on flat sloping rocks, resting in a mere indentation that offers a precarious resting place. In a crowded breeding ground quarrels are incessant, and as a result the eggs are started rolling, and in spite of the extremely thick shells many are broken. Under the St. George cliffs the shells of murre eggs may be found in abundance.

The murres have also a constant and vicious enemy in the glaucous-winged gull, which in sheer wantonness, when hunger does not serve as a reason, attacks the eggs of the murre the moment the latter are left ungarded, and punctures them with a heavy blow of the beak. On Walrus Island clouds of the gulls could be seen to settle on the thickly strewn egg spaces just deserted by murres, and to begin, with every sign of pure maliciousness, to pick at them and to gulp of their contents, perhaps a single mouthful only from each egg. They also would start the eggs rolling down a rock to break at the bottom without any further attention from the gulls. These gulls also have

been seen to sink their bills into murre eggs, and to fly away carrying the eggs so transfixed. On Walrus Island round balls of mashed murre eggshells could be seen everywhere, indicating that birds, probably these same gulls, had gorged their crops with the shells and ejected them afterwards. The murres themselves are not at all hesitant about tumbling each other's eggs off the rocks on which they were laid. Both sexes of the murres must alternate in guarding and hatching the egg, otherwise it would be destroyed by its natural enemies.

The glaucous-winged gull makes its nest on Walrus Island on the area covered by loam, constructed usually of green grass flat on the ground. The nests on June 30 contained two eggs usually, and in a number of cases one egg only. Nests with three eggs were very rare. In endeavoring to photograph the two young gulls just hatched that were found there, the photographer was dealt a vicious blow on the head by one of the parent birds swooping suddenly in its flight, and his hat was sent spinning.

The puffins lay their eggs in tunnels driven through the loam a few inches below the surface and were found sitting on one egg each. A puffin fights viciously when seized.

The red-faced cormorants on Walrus Island are very few in number. It is stated that this island is the only breeding place of this species on the American side of the Pacific, although many breed on the Siberian side.

EXPERIMENTAL STUDY OF THE GROWTH AND MIGRATION OF FRESH-WATER MUSSELS

By Frederick B. Isely

Professor of Biology, Central College, Fayette, Missouri

Appendix III to the Report of the U. S. Commissioner of Fisheries for 1913

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INTRODUCTION.

The growth lines of the Unionidæ have long been considered by many observers as "annual rings," marking the yearly increase in the shell diameter. On the other hand, proof of the correctness of this assumption has been lacking, and not a few investigators have questioned its validity.

If the so-called annual rings do mark yearly additions, the rate of growth may readily be ascertained in many species by inspection; if, however, two or three of these lines appear in one season, or prominent lines appear only at irregular yearly intervals, the importance of "growth lines" as definite indicators of rate of growth loses much of its significance.

The economic importance of fresh-water mussels has added a new stimulus to the study of the growth problem. Investigations[a] under direction of the Bureau of Fisheries during the past five years concerning various phases of and questions related to the problem of artificial propagation of the species valuable for use in the manufacture of pearl buttons, knife handles, etc., has promoted inquiry concerning the time required for an economic species to reach marketable size.

Israel and Haas, among German investigators, have recently given the growth question some attention in connection with their extensive study of the fresh-water mussels of streams of Germany. In this country Lefevre, Curtis, and Coker[b] have gathered experimental data concerning growth.

In my study of the ecology of the Unionidæ during the past five years, one of the perplexing problems has been the rate of growth and

[a] Various papers by Lefevre, Curtis, Coker, and other workers, in Bureau of Fisheries publications, the Journal of Experimental Zoology, and the Biological Bulletin for 1909, 1910, 1911, and 1912.

[b] Through the kindness of Dr. Coker, I have been permitted to read in manuscript the results of his experiments and observations.

the age question. After carrying on experimental work for some time on my own initiative, I was given opportunity in 1910 to undertake the work on a larger scale under the direction of the Commissioner of Fisheries.

PLAN OF INVESTIGATION.

In the experiments to be undertaken I proposed to ascertain the rate of growth, to inquire into the meaning of growth lines, to investigate the relation of age, maximum size, etc., and, as a secondary problem, to gather data concerning migration. The plan of work was, in brief, to collect a thousand specimens of as many species and sizes as could be secured in the region where the work was carried on; in some way mark them individually, weigh, measure, and make any other necessary records; and then return them to their usual habitat and at suitable intervals reclaim, weigh, and measure again.

To carry out this work, two questions of method had to be solved: (1) The marking of specimens and (2) the reclaiming of them.

MARKING OF SPECIMENS.

In 1909 I experimented with two ways of marking: One was to scratch a symbol (pl. I, II), as a Roman numeral, on the shell, and in this way identify it for future records; the second method was to fasten a serial-numbered tag to the shell and keep records by these numbers. In the final work both methods were used, the former for light shells, the latter for heavy ones.

The method of marking a shell by scratching a number on it is simple enough, as a mark cut through the epidermis of a mussel valve will be carried indefinitely. To get a satisfactory series for a large number of specimens, however, is difficult.

The tagging with serial numbers seemed to me to be more exact. For this method I used brass tags about the size of a dime and fastened them to the specimens with a light copper wire passed through a small hole made in the posterior edge of the valve. The hole in the valve was made with a very fine button-eye drill about 2 millimeters from the posterior edge of the shell (pl. I, II, and III). To hold the button-eye drill, a geared hand drill was used, and only a few seconds were needed to drill a hole even in a thick shell. By making a little hook on the wire it could be passed through the hole and out between the valves, usually without much difficulty. In large specimens it was found that the work of tagging could be more readily accomplished by wedging the valves open slightly before inserting the wire. A slight injury to the animal often resulted from the fact that the mantle was not sufficiently drawn back to avoid the drill point. While the irritation at the moment was

doubtless severe, the ultimate effect upon the animal's future growth and activity was insignificant (p. 19).

FIELD RECORDS.

A tabular record was kept of all specimens tagged. The weights were taken in grams, a Harvard trip balance being used; the measurements, length, height, and breadth in millimeters with a steel caliper. The field record form, kept in duplicate, was ruled in columns with headings for number, weight, length, height, breadth, species, and remarks.

PLANTING SITES.

In most cases, after tagging and taking records, the mussels were placed directly back in their original habitats, but in some instances transplanting from river to creek or from pond to river was practiced.

Four different sites were selected for planting: One on Shoofly Creek, on the Corn farm in the north end of Kay County, Okla.; two on the Chikaskia River, on the Brewer and Esch farms near Tonkawa, Okla.; and a pond site on the Browne farm near Autwine. As the pond dried up, due to the unusual drought of 1910, this series does not figure in the results.

The Chikaskia River is a small, clear-water, sandy stream. The sand is coarse, and frequently there are stretches of gravel and occasionally mud banks and small, mud-bottomed side channels. In certain portions of the Chikaskia, Unionidæ are abundant.

Shoofly Creek is a tributary of the Chikaskia. In very dry weather the water stops flowing over the shallow, gravelly stretches; but the ponded sections, often a mile in length and with water 2 to 6 feet deep, have a constant water supply. In certain of these ponded portions mussels are fairly abundant.

PLANTING OF TAGGED SPECIMENS.

In all, about 900 specimens were tagged, weighed, measured, and listed for future observation. For convenience in further discussion these specimens may be grouped into seven lots.

SHOOFLY CREEK.

Shoofly, lot A, 140 specimens, and lot B, 80 specimens.—Nearly all of these were *Quadrula undulata* (three-ridge) and were taken from the direct site where they were planted after tagging. All of the *Q. undulata* (three-ridge) secured in the Shoofly were large; out of some 500 specimens handled in two days, only 4 weighed under 200 grams.

Shoofly, lot C.—Twenty-two specimens of *Anodonta grandis* (floater) were planted in a mud bank similar to the environment selected by this species in this creek.

Shoofly, lot D.—As already indicated, the Shoofly species were mostly *undulata*, with a few *grandis*, and all were large. In order to get a larger number of species and smaller specimens, I collected 168 mussels in the Chikaskia and planted them in the Shoofly. In this lot, *Q. undulata* (three-ridge), *Q. lachrymosa* (maple-leaf), *Q. pustulosa* (warty-back, pimple-back), and *Q. rubiginosa* were represented by fairly good numbers, and nearly all of the specimens were under 200 grams in weight. It should be stated here that a few specimens of all of the Quadrulæ were found native of the Shoofly, and in addition to these, *Lampsilis gracilis* (paper-shell), *Lampsilis anodontoides* (yellow sand-shell), *Symphynota complanata* (heel-splitter), and *Anodonta imbecilis* were found. Not counting *grandis* (floater), the ratio would be 25 *undulata* (three-ridge) to one of another species. This, however, is not unusual in dominance of species in certain streams.

In planting specimens, the bottom was cleared of the original occupants and the tagged specimens were put in their places. For example, for lot D, an area of bottom about 12 feet in diameter was cleared and the Chikaskia specimens spread out on the cleared bottom. The Shoofly bottom, where the sites were located, is made up of a mixture of broken blue shale, coarse sand, and mud. The water is still and cloudy and from 2 to 5 feet deep. The specimens were planted in water about 3½ feet deep. Results that follow indicate that the above is a favorable type of habitat for the species used.

As already indicated, the specimens were free in the stream; no obstruction of any kind was placed in their way, nor any effort made to confine them. The planting operation consisted in turning them out of a sack and spreading them around on the stream floor. In 24 hours after planting it was noticed that most of the specimens had righted themselves and were stuck in the bottom, foot end down, but seldom was a *Quadrula* found with the foot extended.

The Shoofly specimens, lots A, B, C, and D, were tagged, weighed, etc., June 13 to 16, 1910; reclaimed and first checked over in part June 14 and 15, 1911; and a second time some were reclaimed and checked over September 19, 1911.

CHIKASKIA RIVER.

In the Chikaskia two lots were planted. These were inclosed with a wire netting, as I was a little doubtful in regard to reclaiming free Unionidæ in the Chikaskia.

Chikaskia, lot E.—On the Brewer farm were planted 120 specimens of various sizes of Quadrulæ, and a few representatives of the other species mentioned for the Shoofly, with the addition of a few specimens of *Lampsilis purpuratus* and *Tritogonia tuberculata* (buckhorn, pistol-grip). The inclosure consisted of a triangular pen made of 3-foot, 1-inch mesh wire netting, run out from the bank and back again, 40 feet of netting being used in its construction. The bottom was a mud bank along the side and medium coarse sand farther out. The water was from 2 inches to 3 feet in depth, a portion of the main channel running across the lower end. The specimens were collected in part from the immediate vicinity of the inclosure, but, as they were by no means numerous in this portion of the river, about 90 of the 120 mussels were secured a mile farther down the stream. Lot E specimens were planted, weighed, etc., June 23 and 24, 1910, and checked over in part September 26, 1910, and June 22, 1911.

Chikaskia, lot F.—The second planting in the Chikaskia was on the Esch farm, and consisted of 330 specimens, collected mostly from the immediate vicinity, as the mussels in this portion of the river were abundant. The range of size was good, although really small specimens were rare in 1910. The species were about the same as noted under lot D, mostly Quadrulæ, as these are the only common species in this stream. Fifty specimens of *Unio tetralasmus*, a pond form never found in the Chikaskia, were placed in the Esch inclosure. This pen was made by fencing across a side channel formed by a long bar. The channel was 40 yards long and from 4 to 6 yards wide. The bottom was mostly coarse sand. At the time of its construction there was a regular flow of water through the channel, the depth of water varying from a few inches to 3 feet. Lot F mussels were planted June 23 to 28, 1910; examined and rechecked in part September 26, 1910, April 11, 1911, and June 20 and 21, 1911.

GROWTH RESULTS.

In discussing experiments and results, we will first consider growth, and second, migration (p. 19).

The results have shown that much could have been learned from a smaller number of specimens. It was not known, however, that we should be able to reclaim so large a per cent of the specimens first planted. Then, too, it was necessary to guard against loss by accidents, such as changes in course of streams, drifting sand, drying up of water, and other possible environmental changes. The Shoofly specimens were absolutely unmolested; only three dead specimens were found in the whole lot, and these had all started to grow, showing that the tagging certainly had no bad effects. The Chikaskia specimens suffered somewhat from all of the hostile environmental factors

mentioned above; and, further, some were lost to the small boy interested in collecting brass tags.

On the whole, however, the specimens were reclaimed in such large numbers that all of the material could not be worked over for records in the time available when the rechecking and reclaiming was done.

In rechecking material as many specimens were handled as time would permit. As small specimens were few in number, these were always rechecked and care was taken to include representatives of all species. Aside from these influences in selection, specimens were rechecked as found. The left-over material was returned to the stream when it could not be handled. Where a lot was checked over several times, as lot F, naturally the ones worked over the first time they were reclaimed, September 26, 1910, were again followed up in subsequent work.

Far more data were gathered than can be included in this paper. In the tables given below I have stated the reasons for selecting the data presented. Nearly all the material used is selected from lots D and F, as the latter was more available for frequent rechecking, and lot D of the Shoofly material represented a larger number of species and more range as to size.

TABLE 1.—A YEAR'S GROWTH IN YOUNG QUADRULÆ FROM LOT D.

[NOTE.—All starred numbers in tables represent specimens shown in plate figures.]

Specimen No.[a]	Species.	Weight.		Length.		Height.		Breadth.	
		June, 1910.	June, 1911.	June, 1910.	June, 1911.	June, 1910.	June, 1911.	June, 1910.	June, 1911.
		Grams.	*Grams.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*
323*	Q. undulata (three-ridge)	20	43	45	62	31	42	17	23
319	do	49.5	77	64	75	42	50	24	27
341	do	66	102	70	80.5	46	51	27	31
158*	Q. lachrymosa (maple-leaf)	22.5	47	45	56	35	45	19	25
149*	do	26	53	45	59	36	46	20	25.5
159	do	80	112	67	76	55	60	29	33.5
368	Q. rubiginosa	52	65	64	68.5	48	50	26	27
351	do	60	76	64	69	50	52	26	28
353	do	104	115	76	79	60	65	32	33.5
349*	Q. pustulosa (warty-back or pimple-back)	10	20	30	37	25	30	15	20
375	do	54	63	56	58	45	46	28	29
383	do	67	77	64	65	52	53	29	30

AVERAGE GAIN AND PER CENT OF AGGREGATE GAIN FOR EACH SPECIES.

Species.	Weight.		Length.		Height.		Breadth.	
	Grams.	*Per ct.*	*Mm.*	*Per ct.*	*Mm.*	*Per ct.*	*Mm.*	*Per ct.*
Q. undulata	28.8	63	12.8	21	8	20	4.3	19
Q. lachrymosa	27.8	64	11	21	8.3	19	5.3	23
Q. rubiginosa	13.3	18	4.1	6.1	3	5.6	1.5	5.3
Q. pustulosa	9.6	22	3.3	6	2.3	5.7	2	9.7

[a] Specimens listed in all tables according to size for each species.

The foregoing tables relate to Unionidæ from lot D (p. 8) that were planted June 15 and 16, 1910, and reclaimed June 15 and 16, 1911. In the figures given, the first series under each number is the initial record, the second series the record a year later. These specimens show manner and extent of growth in one year's time for four species. They were killed at the time of reclaiming, and are preserved for future study should anyone wish to examine them. It can be seen at a glance that *undulata* (three-ridge) and *lachrymosa* (maple-leaf) are rapid growers in comparison with *pustulosa* (warty-back, pimple-back) and *rubiginosa*. Further averages and percentages are worked out for each species listed in table 1 and later tables on page 8.

TABLE 2.—TWO PERIODS OF GROWTH, OF ONE YEAR AND OF THREE MONTHS, RESPECTIVELY, IN SPECIMENS TAKEN FROM LOT D.

[NOTE.—Starred numbers represent specimens shown in plate figures.]

Specimen No.	Species.	Weight.			Length.			Height.			Breadth.		
		June, 1910.	June, 1911.	Sept., 1911.	June, 1910.	June, 1911.	Sept., 1911.	June, 1910.	June, 1911.	Sept., 1911.	June, 1910.	June, 1911.	Sept., 1911.
135	Q. lachrymosa (maple-leaf)	*Gms.* 92.5	*Gms.* 124	*Gms.* 142	*Mm.* 70	*Mm.* 76	*Mm.* 81	*Mm.* 57	*Mm.* 63	*Mm.* 66.5	*Mm.* 32	*Mm.* 36	*Mm.* 37.5
165	do	152	182	194	93	96	97	57	61	63	37	39	40
146	do	164	216	237	82	89	94	68	70	72	41	43.5	45
168	do	166	185	197	93	96	98	57	61	63	37	39	40
283	Q. undulata (three-ridge)	95	132	150	72	83	88	46	51	56	34	38	39
317	do	120	147	162	83	88	92	51	56	61	34	37	38
329	do	125	149	159	85	88	90	55	60	62	34	37	38
306	do	140	164	176	90	96	100	56	60	62	35	37	38
171	do	145	175	190	88	94	97	52	55	58	37	39	39.5
166	do	166	192	214	92	97	102	56	.....	.....	38	40	41
307	do	183	217	230	98	102	105	64	69	72	35	37	38
322	do	185.5	207	220	93	97	99	60	62	64	41	42	42.5
163	do	200	226	236	98	102	104.5	58	.....	.....	42	43	44
374	Q. pustulosa (warty-back, pimple-back)	35	45	50	51	55	57	43	45	47	24	25	27
363	do	60	73	80	55	57	59.5	49	51	52	29	31	32
384	do	87	102	112	63	65	66	55	57	57	34	36	36.5
377	do	90	107	114	79	82	85	57	59	60	31	32	33
358	do	135	145	152	88	89	90	65	66	67	33	35	35.5
355*	Q. rubiginosa[a]	68	75	84	64	67	70	49	50	52	29	30	31
371	do	87	97	104	76	78	80	53	55	55	31	32	33

[a] It should be noted that five of the specimens for the two last species were more nearly mature for these species than the specimens of *undulata* (three-ridge) and *lachrymosa* (maple-leaf).

The specimens shown in the preceding table were planted June 15 and 16, 1910, and were reclaimed June 15 and 16, 1911, put back in the stream, and reclaimed September 9, 1911. All of the specimens of lot D that were reclaimed twice, measured, and weighed, are shown in table 2.

In the figures given above, the first is the initial record, the second the record one year later, and the third a three months' summer record (June 15 and 16 to Sept. 9, 1911).

Table 2 simply adds to the data of table 1 in regard to annual growth, growth of species, etc. It adds the fact of seasonal growth,

and gives data for comparison of yearly growth and summer months. The average yearly growth for 20 specimens shown in table 2, as well as the growth for three summer months (85 days) is shown below:

	Weight.		Length.		Height.	Breadth.
	Grams.	*Per cent.*[a]	*Mm.*	*Per cent.*[a]	*Mm.*	*Mm.*
Average gain for one year, 1910–11	23.2	18	4.2	5.2	3	2
Average gain for three months, 1911[b]	12.1	8.2	2.9	3.4	2.4	1

[a] Per cent of aggregate gain.

[b] It should be noted in this comparison that the 1910 and 1911 summer months were different in weather conditions. During 1910 there were no rains heavy enough to raise the creek and wash out the food supply of micro-organisms, while in 1911 there were two periods of high water, one in July and one in August.

Per cent of gain gives a truer basis for this kind of comparison than the average net gain. The lack of conformity in the height averages, when compared with other measurements, is doubtless due to error on account of the great difficulty in getting this dimension in rapid field measurements because of the circular ventral margins of these species.

TABLE 3.—SEASONAL GROWTH.

Specimen No.	Species.	Weight.				Length.			
		June, 1910.	Sept., 1910.	Apr., 1911.	June, 1911.	June, 1910.	Sept., 1910.	Apr., 1911.	June, 1911.
		Grams.	*Grams.*	*Grams.*	*Grams.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*
594	Q. undulata (three-ridge)	210	222	222	225	102	104	104	104
734	do	255	269	271	270	116	122	122	122+
678	do	261	273	272	277	110	112	112	112
573	do	290	305	305	305	118	125	125	125
644	Q. lachrymosa (maple-leaf)	104	116	114	116	76	76	76.5	77
753	do	105	115	117	123	66	67	68	70
665	do	154	167	167	172	84	86	86	86+
660	do	160	173	171	180	86	88	88	89
687	do	163.5	174	176	182	84	86	86	86.5
694	do	164	180	179	180	86	89	89	90
622	do	187	195	200	200	90	91.5	91.5	91.5
617	Q. pustulosa (warty-back, pimple-back)	91	98	98	99	64	64.5	64.5	64.5
689	Q. rubiginosa	141	146	146.5	147	84	86	86	86
721	do	148	154	156	156	84	86	86	86

While table 2 has given some good data concerning seasonal growth, table 3 gives more detail and permits a more exact location of the growth periods. Table 3 specimens are from lot F, Chikaskia River. These specimens were checked up, approximately, at the third, ninth, and twelfth months that they were under observation, and the results are shown by successive records. The initial records were taken June 23–28, 1910; second, September 26, 1910; third, April 11, 1911; and fourth, June 20, 1911. Only the weight[a] and length records appear in this table. The average gain for the different periods we find to be as follows:

[a] Some observers report weight measurements subject to a great deal of variation. In this investigation I have always kept the specimens out of water for short intervals and always under cover. Under these conditions I have found weight measures very satisfactory and stable under repeated reweighings.

Time.	Weight.	Length.
	Grams.	*Mm.*
June 28 to Sept. 26, 1910	10.9	2.4
Sept. 26 to Apr. 11, 1911	.5	.1
Apr. 11 to June 20, 1911	2.5	.3

For comparison with these averages we have the results from lot E, which I have not tabulated, for 14 specimens: 7 *lachrymosa* (maple-leaf); 4 *undulata* (three-ridge); and 3 *pustulosa* (warty-back, pimple-back). In this case the April reclaiming was not done.

Time.	Weight.	Length.
	Grams.	*Mm.*
June 23 to Sept. 26, 1910	9.1	1.0
Sept. 26 to June 23, 1911	5.4	.55

The second period shows a gain in the growth for lot E over lot F. The explanation is one of food and possibly oxygen, and appears later (p. 24) under the discussion of migration.

The following four tables show proportional rate of growth, at different ages, of a single species, *Q. undulata* (three-ridge). The fact that lot D mussels were transplanted (p. 5) brings in an additional factor (footnote, p. 23), but I am not sure that this is material. In making these comparisons weight and length are used.

TABLE 4.—INCREASE IN ONE YEAR OF SPECIMENS FROM LOT D, WEIGHING LESS THAN 100 GRAMS.

Specimen No.	Weight.		Length.		Specimen No.	Weight.		Length.	
	June, 1910.	June, 1911.	June, 1910.	June, 1911.		June, 1910.	June, 1911.	June, 1910.	June, 1911.
	Grams.	*Grams.*	*Mm.*	*Mm.*		*Grams.*	*Grams.*	*Mm.*	*Mm.*
323	20	43	45	62	313	70	101	74	83
319	49.5	77	64	75	287	85.4	107	79	85
299	50	70	67	76	283	95	132	72	83
341	66	102	70	80.5	282	100	124	82	.....

TABLE 5.—INCREASE IN ONE YEAR OF SPECIMENS FROM LOT D, WEIGHING UNDER 200 GRAMS.

Specimen No.	Weight.		Length.		Specimen No.	Weight.		Length.	
	June, 1910.	June, 1911.	June, 1910.	June, 1911.		June, 1910.	June, 1911.	June, 1910.	June, 1911.
	Grams.	*Grams.*	*Mm.*	*Mm.*		*Grams.*	*Grams.*	*Mm.*	*Mm.*
336	120	135	79	(a)	304	145	163	89	92
317	120	147	83	88	292	149	172	94	.....
329	125	149	83	86	331	163	182	91	.....
290	131	160	87	94	310	187	222	95	.....
333	134.5	160	89	(a)	339	195	225	99	102

a No record.

TABLE 6.—INCREASE IN ONE YEAR OF SPECIMENS FROM LOT B, WEIGHING OVER 200 GRAMS, SELECTED AT RANDOM FROM 20 SPECIMENS ONE YEAR FROM DATE OF PLANTING.

Specimen No.	Weight.		Length.		Specimen No.	Weight.		Length.	
	June, 1910.	June, 1911.	June, 1910.	June, 1911.		June, 1910.	June, 1911.	June, 1910.	June, 1911.
	Grams.	*Grams.*	*Mm.*	*Mm.*		*Grams.*	*Grams.*	*Mm.*	*Mm.*
216	193	215	110	111	244	282	300	114	115
239	226.5	246	101	101	201	291	302	119	120
211	240	263	115	116.5	242	308	322	114	114
251	250	265	110	111	205	323.5	335	115	116
219	258.5	270	110	111	249	378	394	119	120

TABLE 7.—INCREASE IN ONE YEAR OF SPECIMENS FROM LOT A, WEIGHING OVER 200 GRAMS, SELECTED AT RANDOM FROM 68 SPECIMENS RECLAIMED ONE YEAR FROM DATE OF PLANTING.

Specimen No.	Weight.		Length.		Specimen No.	Weight.		Length.	
	June, 1910.	June, 1911.	June, 1910.	June, 1911.		June, 1910.	June, 1911.	June, 1910.	June, 1911.
	Grams.	*Grams.*	*Mm.*	*Mm.*		*Grams.*	*Grams.*	*Mm.*	*Mm.*
70	199.5	216	96	97	9	266.5	277	125	125.5
80	223.5	235	107	108	5	270	285	114	115
10	240	260	106	107	15	273.5	304	120	120.5
12	252	270	125	125.5	2	316	342	120	120+
1	256.5	274	106	107	23	328	340	125	125.5

AVERAGES FOR ONE YEAR.

	Average increase in weight.	Average length.	Average increase in length.	Increase in length.
	Grams.	*Mm.*	*Mm.*	*Per cent.*[a]
Table 4	27.5	66.1	11.6	17.5
Table 5	24.55	88.9	3.5	3.9
Table 6	16.15	112.7	.8	.7
Table 7	17.75	114.4	.7	.6

[a] Per cent of aggregate increase.

The specimens under 100 grams make the largest increase in weight and length; those under 200 grams, the second; and those over 200, or fully mature specimens, fall short. A point of special interest in connection with tables 6 and 7 lies in the fact that while per cent of gain in length is almost negligible, weight goes steadily forward in fairly good proportion. From averages in tables 4 and 5, an average yearly growth for a young *undulata* (three-ridge) might be put at 25 grams in weight and from 5 to 25 millimeters in length; at this rate it would take about eight years to reach the weight of 200 grams and a length of 90 to 100 millimeters; as later growth is slower, about 12 to 15 years would be a fair estimate for the age of a Shoofly Creek *undulata* (three-ridge) of 300 grams in weight and 110 to 120 millimeters in length.

TABLE 8.—RATE OF GROWTH BY SPECIES.

[NOTE. This table shows species not mentioned in other tabulations, because the number of individuals was too small for comparative study. The records are useful as indicative of what may be expected from these species. The Quadrulæ here listed are given because of their use in plate figures.]

Specimen No.	Species.	Time.	Weight.	Length.	Height.	Breadth.
			Grams.	*Mm.*	*Mm.*	*Mm.*
109	A. grandis (floater)	When planted	143	120	63	41
		1 year later	193	127	66	45
113	do	When planted	144	120	62	41
		1 year later	192	124	65	45
111	do	When planted	211	132	72	48
		1 year later	269	139	74	52
114	do	When planted	281.5	140	82	53
		1 year later	320	142	82	54
281*	Q. undulata (three-ridge)	When planted	16.5	40	27	16
		1 year and 3 months later.	51	65	41	25
564*	Q. lachrymosa (maple-leaf)	When planted	5	22	17	10
		1 year and 3 months later.	20.5	41	32	20
413*	do	When planted	8	27	22	13
		1 year later	18	42	35	19
430	T. tuberculata (buckhorn, pistol-grip)	When planted	128	87	56	31
		1 year and 3 months later.	138	90	58	32
431	do	When planted	470	136	76	50
		1 year later	489	136.5	76.5	50
XI	L. gracilis (paper-shell)	When planted	11	51	26	14
		3 months later	29	69	35	20.5
X	do	When planted	13	55	27	18
		3 months later	55	82	44	28
II*	do	When planted	22.5	63	32	19
		1 year and 3 months later.	84	97	50	33
566*	L. anodontoides (yellow sand-shell)	When planted	97	93	46	34
		3 months later	116	97.5	49	35.5
650	do	When planted	125	103	48	37
		1 year later	138	106	49	37.5
495	do	When planted	180	110	51	43
		1 year later	186	111	51.5	43
V	U. tetralasmus	When planted	25	65	33	20
		1 year later	30	71	36	22
LI	do	When planted	31	70	35	22
		1 year later	43	72	37	23

DISCUSSION OF DATA.

The results set forth in the tables given above speak for themselves and need no extensive explanation.

One striking fact is the cessation of growth during the winter months of the Chikaskia specimens, especially in table 3. There are a number of cases in my field records where a loss is shown in weight for the six months from late September to early April, although in general they hold their own. It has been my observation for several years that the Chikaskia mussels, in the shallow water at least, burrow down into the sand in late October and become abundant again in late April.

For *undulata* (three-ridge), I have given rather complete averages of weight, and comparisons of rate of growth according to size in tables 5–8. From tables 1 and 2 (all lot D), I find the averages given below for the four species named: *Undulata* (three-ridge), 12 specimens; *lachrymosa* (maple-leaf), 7 specimens; *pustulosa* (warty-back, pimple-back), 8 specimens; *rubiginosa*, 5 specimens. From

table 8, *grandis* (floater), 4 specimens; *tetralasmus*, 2 specimens; *gracilis* (paper-shell), 2 specimens; *anodontoides* (yellow sand-shell), 1 specimen.

AVERAGE INCREASES IN WEIGHT AND LENGTH, BY SPECIES.

AVERAGES FOR ONE YEAR.

Species.	Average weight.	Average increase in weight.	Average length.	Average increase in length.
	Grams.	*Grams.*	*Mm.*	*Mm.*
Lachrymosa (maple-leaf)	100	30.8	70	7.5
Undulata (three-ridge)	124	28	82	7.2
Rubiginosa	74	11.4	68.8	3.4
Pustulosa (warty-back or pimple-back)	67	11.5	60	2.7
Grandis [a] (floater)	194	48.6	128	5
Tetralasmus [b]	28	8.5	67	4
AVERAGES FOR THREE SUMMER MONTHS.				
Gracilis (paper-shell)	12	30	53	22.5
Anodontoides (yellow sand-shell)	97	19	93	4.5

[a] Large mature specimens, still the increase is good.
[b] In an unusual environment for this species (p. 9).

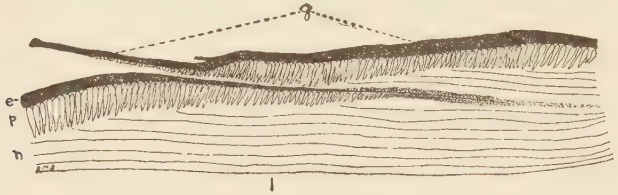
Juvenile Quadrulæ [a] of the above species double in size in a year, as shown by a number of examples (149, 158, 349, 323, in table 1; 281, 564, 413, in table 8). Averages here given and those taken from other sources indicate that a 100-gram, 75-millimeter *undulata* (three-ridge) (p. 14) or *lachrymosa* (maple-leaf) can develop in the Shoofly in about four years (averages for tables 1, 2, 4, and 5). A 300-gram specimen of *undulata* (three-ridge) or *lachrymosa* (maple-leaf) would doubtless be close to 15 years old. The largest *undulata* (three-ridge) rechecked weighed 407 grams in June, 1910, and 421 in June, 1911. This specimen was 123 millimeters long, and increased 1 millimeter in length. In *undulata* (three-ridge) and *lachrymosa* (maple-leaf), after the 100-millimeter length is reached, the increase in length is slow, and growth lines follow one another so closely that the differentiation of lines is difficult. *Pustulosa* (warty-back, pimple-back) and *rubiginosa* grow more slowly than the two preceding species. A 50-millimeter *pustulosa* (warty-back, pimple-back) has passed the age of rapid growth, and from this size on additions come slowly.

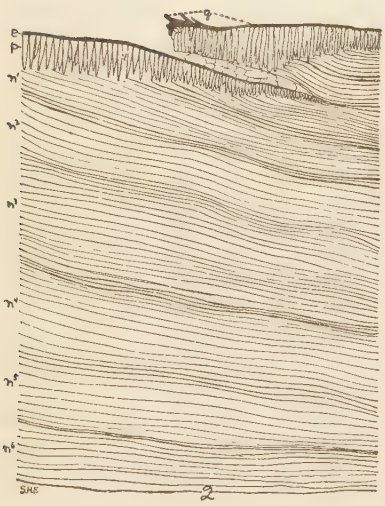
A light-shelled form, as *L. gracilis* (paper-shell) grows very rapidly; this would seem to indicate that the shell is built up at greater expense of food and energy than the soft parts of the mussel. In table 8, specimen X, during the three summer months, shows an increase of over four times in weight and 27 millimeters in length; 566, *L. anodontoides* (yellow sand-shell), in the same time, makes an increase of one-fifth its original weight, and 4.5 millimeters increase in length.

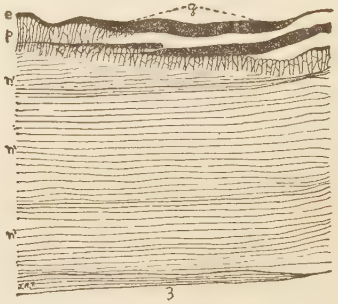
[a] Early juvenile forms grow even more rapidly as experimentally found (foot-note, p. 5) by Coker.

ARRESTED GROWTH RINGS.

"Growth lines," the conspicuous dark concentric rings of the shell, may be due to (1) thick epidermis, (2) double epidermis, and especially (3) to double epidermal and prismatic layers. It is well known that the epidermal and prismatic layers are formed by the







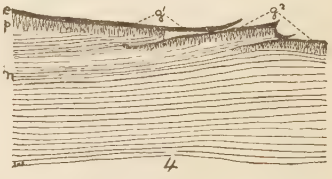


FIG. 1–4.—Cross-sections of shells of *Quadrula* showing structure in region of rest rings, all figures enlarged 20 times; *e*, epidermis; *p*, prismatic layer; *n*, nacreous layers; n^1, successive layers of nacreous structure; *g*, position and width of rest rings (growth lines).

FIG. 1.—Section from near edge of shell, showing double layers and long underlying tongue of epidermal and prismatic structure, which formed the dark wide rest ring of a young rapid-growing *Quadrula lachrymosa*. Rings x^1 or x^2, specimens 149 or 138, plate II, would give similar sections.

FIG. 2.—Section of shell of mature mussel, taken about the middle of the valve. Rest ring not so wide as in 1, tongue shorter, prismatic layer thicker, and thick successive layers of nacreous structure.

FIG. 3.—A rest ring due chiefly to unusually thick, double layers of epidermis.

FIG. 4.—Two successive rest rings near together, undoubtedly formed in the same season, and probably only a few weeks apart, as specimen was young and at the rapid-growing age. (See description of specimen 413, pl. II.)

edge of the mantle only. Thus increase in shell diameter begins with the formation of the epidermal, followed by the prismatic layer. However, if the mantle is withdrawn from the edge of the shell, it often puts down new layers of epidermal and prismatic material

underneath older layers [a] of the same structure, and sometimes underneath older layers of nacre as well. This is well shown in figures 1–4, showing sections of shells made through the growth lines.

In watching the growth of tagged specimens it was noted that a distinct growth line was formed at the time of tagging; the work of tagging, i. e., the drilling of the hole through the shell and the placing of the wire, caused considerable irritation, probably a strong contraction and partial breaking loose of the mantle from the edge of the shell, and, as a result, new epidermal and prismatic layers were put down underneath those already formed, as the mantle worked to its old position, and formed new layers over the wire holding the tag (pl. III, 763). Young specimens, especially, show a conspicuous and well-defined ring passing through the outer side of the wire holding the tag.

The so-called annual rings had better be called "arrested growth or rest rings," as they represent retarded growth, which may be very temporary, as in the case of the tagged specimens, and still leave a very marked ring. Ordinarily the prominent rest rings are presumably winter rings,[b] representing delayed growth, due to inactivity, a withdrawal of the mantle from the extreme edge of the valves, and the forming of double epidermal and prismatic layers as a result of renewed active growth in the following spring. Other rings may follow arrested growth, due to various unfavorable conditions that may arise in the life of the mussel, such as water shrinkage, temporary stranding due to migration, especially at flood periods; in the lighter species perhaps washing at flood times. It is possible that in certain pond forms, as *U. tetralasmus* and others that live in ponds that go dry for short periods during the summer season, the more prominent rings are summer rings.[c]

That the concentric rings are by no means dependable as absolute annual rings is well shown in many specimens under observation in this investigation.

A few specimens shown photographically (pl. I, II, III) will clear up some points in regard to growth. Rest rings are not always brought out clearly by photographic methods on account of the unequal or convex surface of the shell. A slight ridge that may have no connection with a rest ring will show as a shadow line beyond the ridge. This is shown in photograph II, plate I, in the line marked "o." Additional explanations are given with the plate figures.

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[a] This explanation was first suggested to me by Dr. Coker, and later verified in connection with my study of shell sections through arrested growth lines.

[b] While in this paper we have emphasized the point that "annual rings" are not annual rings absolutely, the statement that the prominent rest rings are usually, under stable environmental conditions, winter rings is clearly within the evidence of this investigation.

[c] Live specimens of this species were plowed up in the Browne pond (p. 7) three months after the pond had gone dry.

MIGRATION.

No end of speculation has been carried on as to the traveling ability of mussels. The long undulation tracks, often found upon the pond or stream floor, together with other field observations, and the active movements of specimens kept in aquaria have afforded data for discussion. While gathering information concerning growth, I have constantly kept in mind the migration question, as it was easy to carry on the two together.

As already indicated, the main reason for tagging a large number of mussels was the feeling that many would be lost through migration; and further to guard against this migration in the Chikaskia I inclosed the specimens in good-sized pens.

SHOOFLY.

The extent of actual migration is best shown in considering definite plantings. Lot D (see p. 8) of the Shoofly is good for this purpose. The 168 Quadrulæ planted here were from the Chikaskia, where they were collected from the sand bars in shallow water. From track-mark evidence these specimens had been actively moving about on the sandy bottom, stimulated to activity by unfavorable environmental conditions.

The 164 specimens were spread out on a small portion of the bottom of the Shoofly (p. 8), June 16, 1910, and left free to move. June 14 and 15, 1911, I reclaimed 139 of these specimens, or 84.8 per cent, in about three hours' work. Twelve of these specimens were reserved for records. On September 11, 1911, a cold rainy day, I again checked over lot D, and this time I secured 93 specimens in about one hour's time; the water was so cold that collecting was exceedingly difficult. Three specimens not found in June were found on this date, bringing the total number reclaimed from the original planting up to 142. When we consider that the water was cloudy and from 3 to 4 feet deep the experienced field collector will know that specimens could not be recovered in these numbers unless they were on the very spot [a] where they were planted. Lots A and B in the Shoofly gave similar results, although I did not attempt to recover these as thoroughly as in the case of lot D.

Lot C in the Shoofly is of especial interest, as these specimens were all *A. grandis* (floater). Of this lot 12 specimens were found directly on the site where they were planted. While this is rather a small per cent in comparison with lot D, I was surprised to find 46 per cent of *A. grandis* (floater), as it is well known to be an active

[a] It has been suggested that since lot D specimens were transplanted the inactivity may have been due to the changed environment. The relatively rapid growth and like inactivity of lots A and B, Shoofly specimens, which might very well be considered as control lots, should quiet any apprehensions on this point.

form. In all my reclaiming work in the Shoofly, which amounted to about 10 hours' actual hunting and collecting on three different days, I secured only one specimen that may be said to be off the planting plot; this was no. 141, found 15 feet from plot D.

CHIKASKIA.

In the Chikaskia lot E gave results similar to D. The Chikaskia River specimens were disturbed somewhat by curious people, and for this reason proportional figures can not be emphasized. The inclosure for lot E (p. 9) was rather small, but there was ample chance for movement. The results in this instance substantiate what I have often noticed in field work, namely, that the mussels, especially Quadrulæ and related species, are unable to help themselves if conditions become unfavorable, but, on the other hand, the power to endure these unfavorable conditions is remarkable.

Since the Chikaskia is a fairly swift stream, the lower end of the inclosure was undermined, making escape easy, while a sand bar was formed across the upper portion. Two-thirds of the mussels were caught in the drift bar and when I examined them on September 26, 1910, were helplessly stranded. Conditions of oxygen and food supply must have been unfavorable, and as a direct result the summer's growth was below the average for lot F.

These stranded specimens were now taken and put in the outer corner of the pen, where they could escape under the wire net through an opening 5 feet long. Six months later, June 22, 1911, I again examined lot E. A large number of the specimens were recovered, about half being along the wire net inside, and half along the net outside; not a specimen was found over 5 yards from the pen. Clear water and sandy bottom made the finding of specimens easy.

Lot F specimens of the Esch inclosure (p. 9) had a good opportunity for migration; in fact, the inclosure was not needed, as only two specimens reached either lower or upper cross fences. One of these was a *gracilis* (paper-shell), and the other a *grandis* (floater). The Quadrulæ did not come within 25 yards of the lower fence. If they were placed in water over 3 feet deep, the migration was slight in any case, as far as the Quadrulæ were concerned. Those placed in water as shallow as 1 foot moved to deeper water, which was easily reached in this case. The *Lampsiles* were more active, and the percentage recovered was small by comparison. Of the 50 *U. tetralasmus*, not a single specimen or shell was found at the first examination, September, 1910; but in the June, 1911, examination, three specimens were found. I am not able to explain the disappearance of the *tetralasmus*; however, they are great burrowers, and may have escaped my extensive digging for them.

DISCUSSION OF MIGRATION DATA.

The migration results came as a surprise to me. The very fact that I was willing to risk specimens free in the Shoofly would indicate that I hoped to make some kind of recovery; but to go back and find specimens by the score—apparently in the exact spot where they were planted—was not to be expected. The Quadrulæ in these plantings show little migration; the Shoofly specimens may be said to be nearly stationary in water over 3 feet deep. Those placed in shallow water in the Chikaskia always moved until water 2 to 3 feet deep was found. Specimens found on shoals and bars in nature are there by chance distribution, not choice, although breeding reactions may cause migration in some species.

ECONOMIC BEARING OF EXPERIMENTS—RELATED PROBLEMS.

While the scientific interest in the growth and migration problems was the real motive that prompted this investigation, it was the relation of the problem to the practical question of artificial propagation of mussels for commercial purposes that made funds available to carry on the work. That the results will be of service as preliminary to further investigation is a matter of satisfaction. The man interested in commercial propagation will continue to ask the question, How long will it take to grow a mussel to marketable size? Much more work will be needed to get at all the facts in the case of the various economic species; and where the work of propagation is to be conducted on a large scale, preliminary experiments will be of value in testing the fitness of a particular region for commercial operations. Some of the methods of procedure have been indicated by the series of experiments here outlined.

I wish to call the attention of the field students of the Unionidæ to the transplanting of adult mussels from the Chikaskia to the Shoofly, where young specimens were not to be found, yet these transplanted mussels averaged higher in rate of growth than the regular Chikaskia specimens. If the Shoofly is so favorable a habitat for mussels, why are young specimens absent from the beds?

Again, notice the transplanting of over a hundred specimens from the vicinity of lot F, where mussels are so abundant, to lot E: The transplanted specimens did as well in growth as the specimens that were near the region of abundant mussels in the Chikaskia. This difference in abundance was by no means slight. It is a fact that in the vicinity of lot F one could, in a few hours, collect a wagonload of mussels, while for a quarter of a mile above and below the Brewer inclosure two of us were able to get only 30 specimens in several hours' careful collecting.

The distribution of mussels within individual streams, and in the Chikaskia in particular, is not easy to explain. Little or negligible migration among the Quadrulæ, at least, has not cleared the situation.

SUMMARY.

1. Rate of growth is exceedingly variable for individuals of a single species in the same stream and in different streams, depending, as in other invertebrates, upon season, food, oxygen supply, and other conditions. Juvenile mussels grow much more rapidly than adult or near-adult individuals. *Lampsilis* species grow very much faster than Quadrulæ. Specimens in stable conditions seem to have a fairly definite rate of growth from year to year. The rate, after sexual maturity, is slowed down, but growth goes on steadily, though the proportional increase in length is so slow as to make appreciable additions very slight, so that growth lines in Quadrulæ, after a size of 100 millimeters (4 inches) has been reached, can not be ascertained by inspection.

2. From April to September may be designated as growth months, most specimens showing very slight increase during winter.

3. Lines of arrested growth may be called rest rings, the conspicuous ones being usually winter rest rings; very often, however, the rings may be two or more years apart, or several equally prominent rings may be formed in one year. Prominent lines are generally due to double prismatic and double epidermal layers. Winter rings, especially where environmental conditions are stable, are usually sufficiently regular for use as indicators of age in estimating roughly the time required for a commercial species to reach marketable size.

4. Under favorable conditions there is little migration among the Quadrulæ. Some of the Lampsiles and other light-shelled species move about quite actively, but probably seldom migrate far from the point where they were dropped from the fish, although their total wanderings may be considerable. Water of sufficient depth is essential to optimum conditions. The minimum depth seems to be at least 2 feet; the range up to the maximum has not been studied. Quadrulæ prefer water over 2 feet deep. The reason they are found on the shoals in many of our streams may be explained as chance distribution, due probably to the fact that the particular individuals have never found optimum conditions after their parasitic development, and the reason they move about is that they do not find the right environment.

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EXPLANATION OF PLATES.

All photographs are about natural size. For actual measurements see tables. As already explained (pp. 10, 11, and 15), tags were fastened on with a small copper wire passed through a small hole made about 2 mm. from the edge of the shell, usually along the edge of the posterior umboidal ridge. *x* marks the tagging ring, i. e., the ring formed when the specimen was marked and measured. This ring was formed without exception in all specimens handled and thus marks the diameter of the mussel at the time of tagging and making initial records; x^1, rest rings formed by natural processes between tagging time and reclaiming of specimen; *o*, shadow line due to a ridge on the valve and in photographic cuts may be mistaken for a rest ring.

PLATE I.

Specimen H, *Lampsilis gracilis* (table 8), shows 34 mm. growth in length in 15 months (June, 1910, to Sept., 1911); *x* marks the rest ring formed when the specimen was marked and measured; x^1 is probably the 1910–11 winter rest ring; *o*, shadow line.

Specimen 323, *Quadrula undulata* (table 1), shows 17 mm. increase in one year's growth (June, 1910, to June, 1911). A new ring appears at x^1 near the margin. Notice the two rings, y^1 and y^2, near together, formed before the specimen was tagged.

Specimen 281, *Quadrula undulata* (table 8), shows 25 mm. growth in 15 months (June, 1910, to Sept., 1911); x^1 is probably the winter rest ring.

PLATE II.

Specimen 355, *Quadrula rubiginosa* (table 2), shows 6 mm. increase in 15 months (June, 1910, to Sept., 1911) in a mature slow-growing species. No evidence of rest rings beyond *x*.

Specimen 349, *Quadrula pustulosa* (table 1), shows 10 mm. increase in one year (June, 1910, to June, 1911). A rest ring, not well brought out by the plate figure, shows very near the margin; *o*, on the anterior slope, is a shadow line.

Specimen 564, *Quadrula lachrymosa* (table 8), shows 19 mm. increase in length in 15 months (June, 1910, to Sept., 1911). Tag pulled off (*t*) after specimen was reclaimed.

Specimen 413 (table 8), shows 16 mm. increase in one year (June, 1910, to June, 1911). Two rest rings, x^1, x^2, in addition to the regular, *x*, formed at the time of tagging. If we count the one at the tagging line we have three rest rings for one year.

Specimens 149 and 158, *Quadrula lachrymosa* (table 1 and as shown here about two-thirds natural size). These specimens are from the Shoofly, the two *lachrymosa* above from the Chikaskia. The rest rings are about the same as 413 and the time (June, 1910, to June, 1911) is the same.

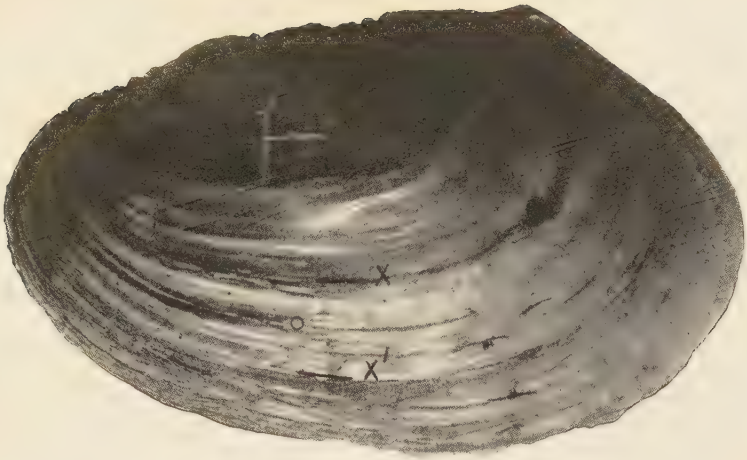
Specimen 158 is the left valve and so does not show the tag or mark.

PLATE III.

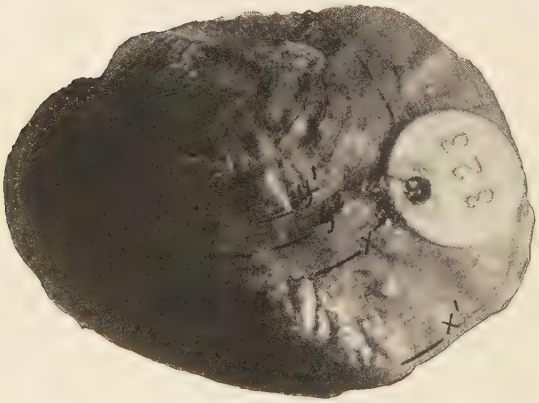
Specimen 566, *Lampsilis anodontoides* (table 8) ,shows 5 mm. increase in length in nearly three months (June 27, 1910, to Sept. 19, 1910). A mature Chikaskia specimen growing in rather unfavorable environment.

Specimen 763, *Quadrula lachrymosa*, shows how the tag wire is overlaid with nacre (*t*) nearly three months after tagging (June 27, 1910, to Sept. 19, 1910).

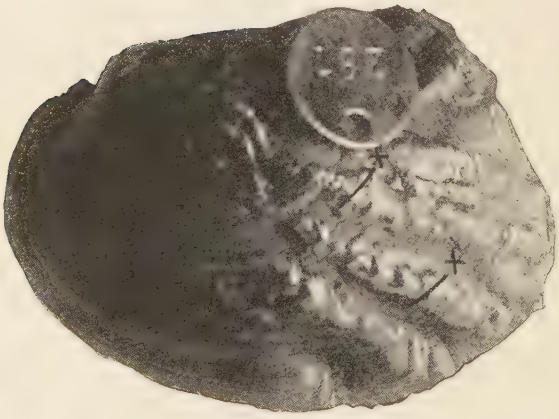
Specimen 200, *Quadrula undulata*. In the Shoofly (p. 7) no *Q. undulata* under 193 grams was found in June, 1910. In 1911 two specimens were secured that may be called young. No. 200 is one of these and is interesting on account of the regularity of rest rings, four in number. The specimen measures 80 mm. in length and, according to estimates worked out upon known growth of this species in the Shoofly, was 4 or 5 years old when taken (p. 14).



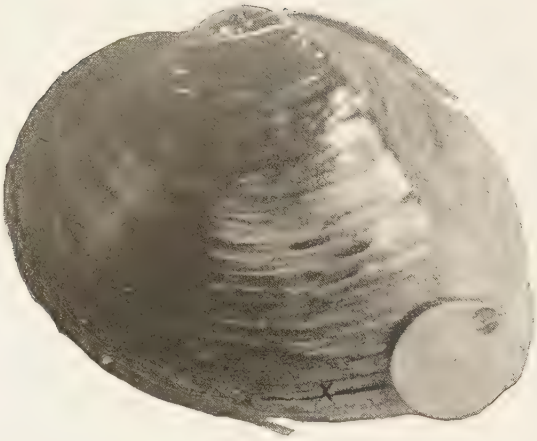
SPECIMEN H.



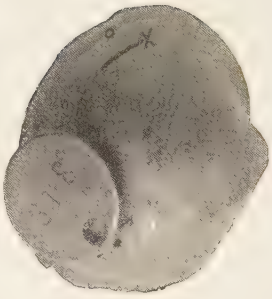
SPECIMEN 323.



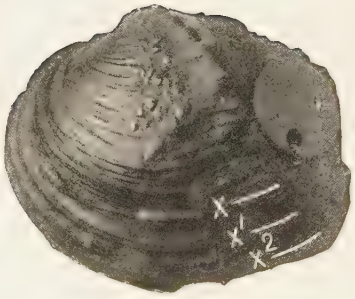
SPECIMEN 281.



SPECIMEN 355.

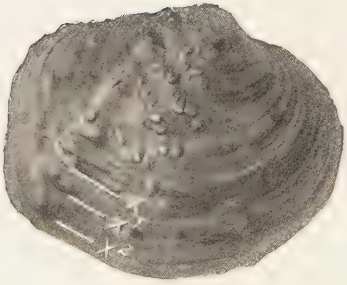


SPECIMEN 349.

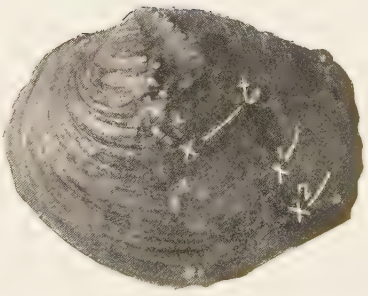


SPECIMEN 149.

SPECIMEN 564.

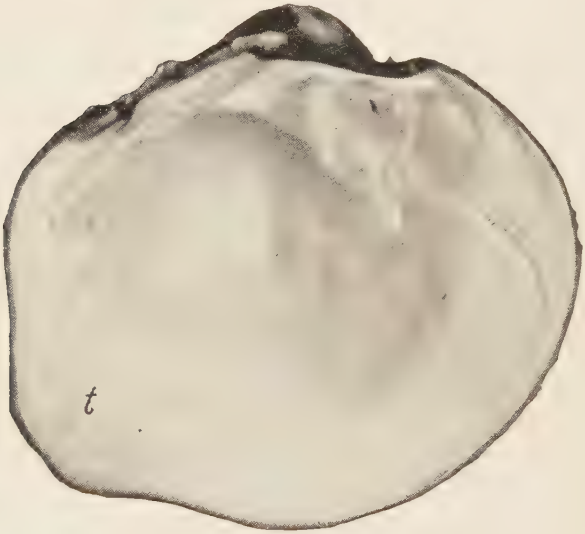


SPECIMEN 158.



SPECIMEN 413.

SPECIMEN 566.



SPECIMEN 763.

SPECIMEN 200.

EXPERIMENTS IN PROPAGATION OF FRESH-WATER MUSSELS OF THE QUADRULA GROUP

By Arthur Day Howard

Scientific Assistant, United States Bureau of Fisheries

Appendix IV to the Report of the U. S. Commissioner of Fisheries for 1913

22889°—14——26

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EXPERIMENTS IN PROPAGATION OF FRESH-WATER MUSSELS OF THE QUADRULA GROUP.

By Arthur Day Howard,
Scientific Assistant, United States Bureau of Fisheries.

INTRODUCTION.

The fresh-water mussels of central North America with their heavy shells of beautiful pearl are a natural resource the value of which probably has not begun to be realized. The extensive development of the pearl-button industry in a brief period of 20 years is evidence of the wealth of the original natural supply; but a very evident decrease of readily obtainable shells, along with the increasing necessity for extension of clamming operations to more and more distant sources of supply, has made it evident that this resource is not unlimited.

Within the first 10 years of the growth of the industry, interested manufacturers requested an investigation of conditions by the United States Bureau of Fisheries. The purposes of this first investigation (Smith, 1899, Simpson, 1899) were to discover whether indiscriminate and wasteful methods were being employed that might be corrected by supervision or restrictive legislation. Later there were carried on for a number of years investigations to determine if methods could be found for artificially supplementing the natural production of young mussels, i. e., methods similar to those so successfully employed by the Bureau in the culture of oysters, trout, lobsters, and other water forms of economic importance.

The essential facts in the life history of the fresh-water pearl mussels (Unionidæ or Naiades) have been known since the discovery by Leydig in 1866 that at one stage they are parasitic upon fishes. An historical account of these discoveries and the life history of fresh-water mussels, together with methods which have been adopted for their propagation, have been described in publications by the Bureau of Fisheries (Simpson, 1899, Lefevre and Curtis, 1912). The work in propagation, however, has been limited to a few species

of the *Lampsilis* group, chiefly *Lampsilis ligamentina* and *L. anodontoides*. With one possible exception, none of the *Quadrula* group of mussels, including some of the most valuable commercial shells, had been, up to the time of the present investigation, carried through the parasitic stage, though many experiments had been made on various species of fish and under varied conditions to determine a suitable method of propagation. The rarity of successful infections, along with other indications, suggests that, as in other cases of parasitism in the animal and vegetable kingdom, each mussel may have its appropriate host or hosts restricted to a species of fish, a genus or a family, as the case might be, and that the reason for failure was due to not finding the proper host.

Since the number of species of mussel for this locality (Fairport, Iowa) is 40 or more and the number of species of fairly common fish at least 60, the problem of determining the appropriate host for each mussel is obviously quite complex. To determine the hosts for each species of mussel by artificial infection, a "trial and error" method would be roundabout and difficult. Obviously a more direct solution of the problem, as I have shown in a previous paper (Howard, 1912), would be secured by a study of natural infections, i. e., fish taken at large are examined for glochidia and when present these are determined as to species, condition, etc. In the present investigation of some of the *Quadrula* group of mussels the above method was the one chiefly employed. Studies were begun in February, 1912, upon assignment of the problem by the director, Dr. R. E. Coker, at the Government biological laboratory at Fairport, Iowa.[a]

METHODS AND TECHNIQUE OF EXPERIMENTS.

As stated above, the matter of first importance in determining how to propagate a given species of mussel seemed to be the finding of a suitable host. In making this search I have examined as many local species of fish as were obtainable, identifying, if possible, all glochidia found upon the gills or fins. Some glochidia, because of peculiarities of form or size, were readily determined, while others were less easily identified because of fewer apparent differences. In this study I have made identifications by comparison of the glochidium found in the natural infections with a series of preparations and drawings of glochidia (see Surber, 1912) obtained from gravid mussels.

Fishes were examined for natural infections wherever obtainable, but attention was also given to securing them in the vicinity of special mussel beds. Infected filaments of gills or portions of fins have been examined and drawn, first in the fresh state and then fixed

[a] Special acknowledgment is due Prof. Lefevre and Prof. Curtis, of the University of Missouri, for data of their experiments placed at our disposal.

in 10 per cent formalin or a one-third saturated solution of bichloride of mercury. The usual histological procedure for whole mounts was followed after fixation. Acid fixing fluids and acid stains have been avoided on account of the delicate calcareous shells of the glochidia. For the sake of accurate comparison in identifications it has seemed desirable to apply the same method of preparation for the natural infections that is used for the glochidia.

When evidence of the natural host was obtained by the above method, the kind or kinds of fish thus designated were tested by artificial infection to verify the results already secured and to determine the possibilities of artificial propagation.

The method of making artificial infections is as follows: Young mussels or glochidia, which are produced to the number of many thousands by each female mussel, are taken from the gill of the latter and placed in a receptacle with the fish to be infected. The myriads of glochidia thus distributed through the water, passing constantly through the gill openings of the fish, become attached to the filaments of the gills or in some cases fasten externally upon the fins. As soon as they become attached there is a reaction of the tissue in the nature of an hypertrophy of the external epithelium which produces a cyst enveloping the glochidium.

For a fuller discussion of infection methods I would refer to the paper by Lefevre and Curtis (1912). Some special difficulties encountered in dealing with the short-period breeding *Quadrulas* will be discussed in connection with the propagation of *Quadrula pustulosa* and artificial infection of *Quadrula ebena*.

Glochidia were obtained from gravid mussels collected with the "crowfoot" and mussel rake, the usual methods in vogue among clammers. The preparation of these was for the most part by the method described by Surber (1912). For differentiating the thread gland, Grenacher's borax carmine was employed as a stain. Examinations in alcohol covered to prevent evaporation gave better differentiation for some features than the stained and cleared material.

The collection of juveniles has been carried on chiefly by two methods—dredging and hand or shore collecting. The dredge employed was of the Chester rake pattern and of suitable dimensions for use with a gasoline launch. This method is adapted for deep water or for shallow water that is so muddy as to make it impossible to see the bottom. As the Mississippi has been almost constantly muddy during the warmer months this method has proved to be the chief reliance. The small shells are separated from sand and mud by means of a sieve or by washing in a fine-meshed bag. Hand collecting was about the only method applicable to very shallow water and stony bottom, and was employed during winter or on very rare occasions in summer when the water was sufficiently clear.

DETAILS OF OBSERVATIONS.

In the following account, the experiments and observations have been described under the name of each species. This was done for the sake of clearness and convenience, and it will be readily seen that all have not received equal attention. I have followed chiefly the classification and nomenclature of Simpson (1900), in places employing Ortmann's system, in which case it is so indicated. The changes made by Ortmann, so far as they apply to the forms I have considered, seem justified. These are based, according to that author, upon a thorough study of the anatomical characters of the soft parts as well as of the shell. It seems evident enough that a continuance of this kind of revision is very desirable. In this I make no criticism of the herculean labors of Simpson, whose synopsis has removed the taxonomy of the Naiades from chaos.

I have described and figured some of the glochidia in order to bring out features not previously considered, while others previously published are reproduced in order to show all on the same scale. In the dimensions the "height" signifies the longest axis perpendicular to the hinge line, while the "length" is the longest axis parallel to the hinge line. The range given for each dimension is the extent of variation that I have observed. The greatest that I have measured was 12 per cent. If the measurements had been taken from several broods of glochidia from different localities, this variation would probably be larger.

Very little has been published regarding the juvenile stages of the *Quadrulas*. It is not my intention to go into details of description here, reserving such observations for a later paper; however, a few notes are given by way of calling attention to this little-known stage. I regard a knowledge of these as necessary for a proper consideration of the problems connected with the propagation of mussels. If the suggestion (Lefevre and Curtis, 1912, p. 192) that propagation be carried through this stage prove to be feasible, such information would be indispensable. Again, a knowledge of these is required for the maintenance of proper conditions for the natural development of mussel beds. From the few observations that have been published upon juveniles of North American Unionidæ (Isely, 1911; White, 1905; Sterki, 1911 a, b), it seems probable that, in some cases at least, they have a habitat quite different from the adult. For example, some species, such as the yellow sand-shell, *Lampsilis anodontoides*, and the butterfly, *Plagiola securis*, have been found in the shallow water of rapids or riffles attached to stones or gravel by a byssus, while the adult dwells in deep water on a mud or sand bottom. Differences so great between the habitat of the young and the adult would be important considerations in any attempt to raise mussels artificially through this stage.

THE WARTY-BACK, *Quadrula pustulosa* (Lea). [Pl. 1, fig. 1, 2.]

This mussel, with allied species, is commonly called the warty-back and pimple-back because of the pustules on the shell. It is a shell of good luster and texture, and therefore is ranked high by manufacturers.

Distribution.—Its range is throughout the Mississippi drainage and into Michigan, extending east into the Alabama River system and west into central Texas.

Habitat.—It is found in streams of some size either in gravel or on mud bottom (Scammon, 1906).

Juvenile.—The juvenile, of 10 to 20 mm. in length, can be recognized by a broad triangular green ray upon the lateral slope. I have found it chiefly in fine gravel or sand in a strong current.

No byssus was observed in a considerable number of specimens taken and none has been reported for this species to my knowledge; apparently, however, there is a byssus gland present. In the very early stages (less than 1 mm. in length) a mucilaginous secretion is produced which serves to anchor the young mussel. I think it doubtful if this species at any stage produces the hard hyaline byssus threads which are found in some of the Lampsilinæ. Among the *Quadrulus* here described the only case of a true byssus observed was in that of a specimen of *Q. plicata* having a length of 4.5 mm.

Glochidium (pl. v, fig. 36).—The warty-back is a summer breeder, or tachytictic, the glochidia being found during the months of June, July, and August. The earliest record that I have for a season is June 12, and the latest August 23, when I found two gravid out of 46 examined. The glochidia occupy all four gills in the female, and are white in color. They are of the hookless type, and as seen flatwise, the usual position for examination under the microscope, have the form of an elongated purse (pl. v, fig. 36).

Dimensions: Height, 0.28 mm. to 0.3 mm.; length, 0.22 mm. to 0.23 mm.; length of hinge line, 0.08 mm., or 2.75 times in length. The difference in height observed (0.28 mm.–0.3 mm.) gives a variation of less than 8 per cent; more than 10 per cent seems to be uncommon in glochidia of one species, although I have seen 12 per cent. This species should not be confused with any others in the region investigated because of unique form and size. The only glochidia here at all resembling it are those of *Lampsilis luteola* and *Plagiola securis*. *L. luteola* can be distinguished by its relatively greater width (0.25 mm.) and hinge line (0.118 mm.), and *Plagiola securis* by its greater length (0.31 mm. to 0.33 mm.) and different proportions.

Natural infection.—The first record for a natural infection by this species was found upon a catfish obtained July 5. This was the channel cat, *Ictalurus punctatus*, and was the first record of infection

found on catfishes. Previous to that time all examinations of catfishes had favored the belief that they were immune to all glochidial infection. Other records for this fish were obtained through July and August, the breeding period for the mussel. The fish were taken by seining over known shell beds in one instance, in others in wing nets and bait nets of commercial fishermen. In all, during 1912, 17 records of infection were obtained out of 39 fish examined, and 9 of these were determined as *Q. pustulosa*.

This glochidium is more readily identified in infections than some others, because of its large size and owing to its peculiar shape. None of the mussels of similar dimensions have the same form. The nearest approach to it is *Lampsilis luteola*. (See description of glochidium above.) The glochidia in infection were usually well encysted, and in many cases development was far advanced, even to the extent of some growth beyond the glochidial shell. (Pl. III, fig. 19, 23.) This development of an extra embryonic shell in the parasitic stage has been reported (Coker and Surber, 1911) for the *Proptera* (Ortmann, 1912) group, but not, I believe, among the *Quadrulas*. One record only was obtained of *Q. pustulosa* on another fish, the yellow cat, *Leptops olivaris*, but this was important, as it suggested a possible host for this mussel, and led to the discovery of many infections in *Ictalurus punctatus*, although one had been seen in that species before. In 9 other specimens of *L. olivaris* examined by me and 44 by Mr. T. Surber in August, no infections were found. From the standpoint of natural infections, *I. punctatus* is indicated as the natural host for *Q. pustulosa*, with a possible extension to other species of the *Siluridæ*. After August 28 and during the autumn no natural infections were obtained from a total of 98 fish examined. This date corresponds with the latest date for gravid mussels of the species. On August 23, 2 gravid shells were secured from a total of 48. After this date none were found in a total of 176 examined. This gives a space of five days after the last gravid mussels were found, during which the natural infections were obtained The indications from this are that the parasitic period is brief. If the parasitic period were a long one, say a month, this correspondence of dates would be lacking.

The character of the cysts and their position on the gill filament are features to which attention has been called as of importance, perhaps, in determining the possibilities of artificial infection. The cysts of *Q. pustulosa* on *Ictalurus punctatus* are of ordinary size. They are often set off by a slight furrow or indentation (see pl. III, fig. 23), which is quite characteristic. The position is chiefly on the edge of the filaments, often near the base, a rather unusual location. Lefevre and Curtis (1912) are of the opinion that those fish in which the glochidia are distributed on the tips of the filament are able to carry

a much greater number. An attachment near the base of the filament giving a more intimate relation with the host may insure more certain survival to the glochidium. However, the cysts I have examined gave no evidence of serious interference with circulation in the filament, so it looks as if the position in the case of the catfish probably would not make much difference in the effect on the host.

The finding of glochidia on the catfishes is of interest, since this fish had been regarded as belonging to the immune class, this opinion being based largely on the results of artificial infection. The habits of the fish as a bottom feeder, and especially as a voracious eater of mussels, would make it seem surprising if it did not carry the glochidia of some species of mussel. Forbes and Richardson (1908), in examination of the food of these fish, say:

> Mollusks, about equally large water snails, and large, thin clams were a decidedly important element, being found in 15 of the 43 fishes. They amounted to 15 per cent of the food of the group, and several specimens had little or nothing else. Notwithstanding the number of bivalves eaten by this fish, no fragment of a shell was ever found in their stomachs, but the bodies of the mollusks seem to have been separated while yet living from the shells, as indicated by their fresh condition and by the fact that the shell muscles were scarcely ever present.

TABLE 1.—ARTIFICIAL INFECTIONS WITH QUADRULA PUSTULOSA.

Date.	Experiments.	Species of fish.	Number of fish.	Number of glochidia attaching.	Date liberated.	Period on fish.	Development at latest observation.	Average temperature.
1912.								°F.
Aug. 21	V-22	Ameiurus melas	6	88	Aug. 27-29	6 to 8 days	Complete	75.1
23	V-26	do	2	230		More than 8 days.	do	75.5
1913.								
June 12	VI-1	Ameiurus melas, nebulosus	7	500	June 27-29	15 to 17 days.	do	72.1
24	VI-4	L. olivaris (wt. ½ lb.)	1	Many		11 days	Advanced.	78.3
24	VI-4	L. olivaris (wt. 2½ lbs.)	1	do		9 days or less.	do	
July 7	VI-10	Ictalurus punctatus	8	do	July 16-18	9 to 11 days.	Complete	78.1
10	VI-12	do	10	do.[a]	July 20-21	10 to 11 days.	do	76.7
10	VI-12	Lepomis pallidus	2	Several	July 11	1 day	None	
10	VI-12	Pomoxis sparoides	2	Very few	do	do	do	
10	VI-12	Pomoxis annularis	3	do	do	do	do	
29	VI-19	Ictalurus punctatus	1	Many	Aug. 8	10-12 days	Complete	76.3
29	VI-19	Aplodinotus grunniens	1	Few	July 29-30	1 day	None	
29	VI-19	Leptops olivaris	1	Several	Aug. 6-8	8 to 10 days.	Complete	
29	VI-19	Pomoxis sparoides	2	None				
29	VI-19	Micropterus salmoides	1	Many	July 31	1 day	None	
Aug. 4	VI-20	Ictalurus punctatus	29	do	Aug. 15-16	11 to 12 days.	Complete	75.5
4	VI-20	Leptops olivaris	3	do	Before Aug. 9	Less than 5 days.	?	76

[a] On gills and barbels. All other glochidia were attached to gills only.

As *Q. pustulosa* is a heavy-shelled species it may not supply the catfish with food by way of returning favors, unless the fish has some means of opening the heavy shells. However, as mussels of various species segregate in the same location, forming beds, the thinner-shelled species in furnishing food to the fish would favor the

breeding of the heavier-shelled species. This attraction of the fish would serve to furnish the host and also increase the chances of the young mussels being shed there by the fish, thus partly accounting for the segregation of mussels. The fishermen on the Mississippi take advantage of this appetite in the catfish by baiting nets with the "meats" of the mussels which the clammers or mussel fishermen remove from the shells.

Artificial infection.—The finding of glochidia of *Q. pustulosa* on catfishes in natural infection suggested testing these fishes in experiments in artificial infection.

In these experiments four species of catfish were tried and five other kinds of fish. The results of some of these experiments are shown in table 1.

When exposed to infection in the same tank and thus under the same conditions, the difference in susceptibility between the catfish and the other species was very marked and the difference in implantation still more so. The catfish in general received them more quickly and retained the glochidia, while, though abundant on the gills of some of the other species, they disappeared before the end of the second day.

The results in the case of the different species of catfish were not uniform. The duration of the parasitic period seems to vary slightly in the different species and there is evidence of immunity in some individuals of *Leptops olivaris*. The greatest variation in duration of parasitism occurred in the case of the bullheads *Ameiurus melas* and *A. nebulosus*. (See table 1, experiments V–22 and VI–1.) The long period, 17 days, can be explained by the lower temperature (average 72.1° F.); but the temperature of 75.1° F. for the shorter period of 6 to 8 days is no higher than those in which the parasitism is of much longer duration.

The experiments with *Ictalurus punctatus* gave more definite and regular results than with any of the other species. The majority of the experiments were conducted between June 18 and August 14, during a season when the water temperatures were more uniform than usual. This probably accounts for the uniformity in the parasitic period, which was determined as 9 to 12 days. The minimum period on a fish is less readily determined than the maximum; taking this into account it is probable that the period may be less than 9 days for some. This seems a remarkably short period when we consider cases of winter-breeding mussels carried over six months by the fish.

The young mussels after dropping from the fish were secured and their structure and habits noted.[a]

[a] During these early stages I observed cases of ingestion by a turbellarian very abundant in the aquarium This, with the number of empty shells found, indicates a high mortality among them.

The growth of shell, according to my observations, was quite rapid for the first few days; at two weeks it was nearly twice as long as the glochidium; at four weeks no increase was observed beyond that of the second week. This cessation of growth is rather surprising, but is in accord with many observations upon growth under laboratory conditions. Just what is the cause of this inhibition of growth I can only surmise. The young mussels were kept in aquaria having a constant stream of running water coming from the river, their natural habitat. It is quite likely that under these conditions the water contains too small an amount of suitable food material. A further discussion of this matter and a more detailed account of the early juvenile stages I will reserve for another paper.

The evidence of immunity in *Leptops olivaris* will be seen by a comparison of results (see table 1) in experiments VI–4 and VI–20. In the latter the glochidia were all shed in less than 5 days, and thus in all probability did not reach maturity. In experiment VI–4 the small individual carried a large number for 11 days, the usual period of parasitism, while the larger fish on the ninth day had one glochidium only.

This indication of occasional or even common immunity to these glochidia in *L. olivaris* is suggested in studies of natural infections, as I have already shown. The fish is rarely found infected in nature by any mussel, and I have only two records of infection by *Q. pustulosa*. In comparison with this, the abundant infection of *Ictalurus punctatus* (sometimes as high as 50 per cent in a catch) forms a marked contrast and with the foregoing experiments point conclusively to the channel cat as the usual host fish and the most suitable for artificial propagation.

Tests for optimum infection have been made which indicate that a smaller number of glochidia per fish is desirable than in the infections with the "mucket" mussel, *L. ligamentina*. The glochidia in the case of *Q. pustulosa* are considerably larger and the infection must necessarily be made at a season of the year when there is more danger of parallel infection with fungus (i. e., *Saprolegnia*). An infection of 800 to 1,000 glochidia is recommended for a fish of 1 pound weight, 1,500 to 2,000 for a fish of 2 pounds weight, and proportionate numbers for other sizes. Undoubtedly fish released in their natural waters would carry larger infections than those subjected to the more severe conditions of experimentation in captivity. In the foregoing estimates I have taken account of this.

The collection of gravid mussels of this species for artificial propagation requires the taking of some special precautions to prevent the premature discharge of the glochidia. The best results are secured in warm weather with mussels that have been collected the same day and a short time before the infections are to be made. If the edge

of the mantle and shell are uninjured, the gravid mussel may be kept alive out of water several hours, and still longer when kept cool. Mussels caught by the "crowfoot" method are more difficult to keep because of breaks in the shell. It is difficult to prevent abortion of glochidia when a number of mussels are placed together in water even though running as from a tap or when the mussels are placed in crates in a river. On account of this habit of abortion in *Q. pustulosa* and most of the *Quadrulas*, their transportation and retention is more difficult than in the case of the "mucket," *Lampsilis ligamentina*, and the other members of the Lampsilinæ that have been propagated artificially. In the latter the portion of the gill differentiated for a marsupium is relatively so small that the breathing function of the gill is little interfered with by the presence of the embryos, while in the former the presence of glochidia in all four gills is probably responsible for this reaction when proper aeration is interfered with by crowding or otherwise.

Propagation.—This species of warty-back is one of the most valuable of the pearly mussels used in the button industry, so that any practical means of increasing the supply would be welcomed. The determination of the host fish furnishes the means of employing the method of propagation that has proved so successful in the case of *Lampsilis ligamentina* and others of that genus.

In the catfish we seem to have a fish almost ideal for the application of this method. It is abundant and hardy, thus meeting the conditions required by the method, i. e., the securing of many fish and the ability of the fish to withstand the handling and confinement incident to the process of infection with glochidia. The method as employed for the past three years has had some modifications. The fish, after seining, in one instance, were brought to a central station for infection; in the other they were infected in the field and immediately released. Some fish will not survive even the latter very limited amount of handling or confinement; for example, the herring, *Pomolobus chrysochloris*, which has been determined as the host for the niggerhead, *Q. ebena* (Surber, 1913). The power of catfish to survive removal from water is remarkable and this hardihood is an important feature, since the breeding period for these mussels is July and August, when the mortality is highest among fish in captivity.

A third modification of this method, the propagation of mussels in ponds or artificial streams after infection, may prove to be very practicable, as some mussels seem to prosper under these conditions. If, in the case of the commercial species, this method proves successful it will offer the advantage of greater certainty in results. By the method in use at present, the young mussel is released at a stage when it is quite at the mercy of its enemies and results are scarcely ascertainable. If protected until a few millimeters long, when a heavy

shell has been formed, its chances of survival must be tremendously increased. The introduction of mussels into various streams when at this stage has been suggested (Lefevre and Curtis, 1912). This would have the advantage over the method of using the fish for distributing the mussel that transportation in the former case would be much easier and the fish can be used a second time. In this connection comes up the question whether a natural or an artificial distribution is better. It seems likely that conditions of introduction under control would be better then the probably haphazard distribution of young mussels in nature. When they drop off the gills of a fish their finding a favorable location is probably to a large extent a matter of chance. (See, however, discussion of segregation under head of natural infection, p. 11, 12.)

In the study of the juvenile mussels and their environment an attempt has been made to determine these conditions. For *Quadrula pustulosa* apparently a good current of water with proper food content and a bottom of fine gravel are demanded. The conditions of a pond are easier to meet, but the difficulties presented in producing the conditions of a flowing stream seem not to be insuperable.

The season of breeding is an important feature from the practical standpoint. The mussels of the short-breeding period are at some disadvantage because of the limited working season; this, however, is offset by the fact that during breeding months mussels and fish can more readily be obtained.

The number of glochidia per mussel is a feature of practical importance in propagation. As this species has an estimated average of about 200,000 or about one-fifth as many as the "mucket," *L. ligamentina*, it will be seen that a larger number of gravid mussels is necessary for a given number of fish to be infected. This small number as compared with some other species is somewhat offset by the abundance of the species.

The Pimple-back, *Quadrula pustulata* (Lea). [Pl. vi, fig. 37, 38, 39.]

The quite similar *Q. pustulata* I have studied in the juvenile stage, finding it a habitant of sand bars, having 10 records for this location with only 2 for mud or gravel. The natural infections so far identified have been so few that little is known regarding this phase. I succeeded in artificially infecting the following fish with this species: *Pomoxis sparoides*, *Micropterus salmoides*, and *Lepomis pallidus*, but the death of the fish before the end of the experiment precluded the obtaining of any conclusive results. As the species is comparatively uncommon in this region its propagation would hardly be practicable here.

The glochidium has the following dimensions: Height, 0.25 mm.; length, 0.2 mm. (See Surber, 1912.)

THE PURPLE WARTY-BACK *Quadrula granifera* (Lea). [Pl. VI, fig. 40, 41.]

The shell of this species has purple nacre and is therefore not usually saved by clammers. The juveniles are very handsome because of the fine crenulations of the umbones. The glochidium is of large size having the following dimensions: Height, 0.355 mm.; length, 0.29 mm. (Surber, 1912.)

THE MAPLE-LEAF, *Quadrula lachrymosa* (Lea). [Pl. VI, fig. 43, 44.]

The odd sculpturing of this shell, with the coloring of the epidermis, makes it a handsome species. It seems not to be very common in the Mississippi in the region I have investigated, viz, between Hampton, Ill., and Muscatine, Iowa.

Distribution.—Western New York to Kansas and Minnesota, and south to Texas and Alabama. (Call.)

Habitat.—The larger lakes and rivers on a muddy or sandy bottom in somewhat shallow water. (Baker, 1898.)

Juvenile.—I have myself taken only a few juveniles of this species. These were found in shallow water in a rather swift current. The form is so much like the adult that it may be readily recognized.

Glochidium (pl. V, fig. 29).—Eggs were observed the middle of June; they were white in color and occupied all four gills. Early embryos of this species were found in four out of five specimens examined June 27. According to these observations, mature glochidia would be found during July in this region. Mature glochidia were obtained in August, 1912, from a tributary of Fall River, Glenwood County, Kans.,[a] and also June 12, 1913, at Fairport, Iowa. Form, of the purse-shaped type, similar to *Q. metanevra.*

Dimensions: Height, 0.085 mm.; length, 0.078 mm. This is the smallest glochidium of the *Quadrula* group that I have seen. Ortmann (1912) places *Tritogonia tuberculata* (Simpson) in the genus *Quadrula* on the basis of its anatomical structure. In its shell sculpture, though peculiar, he recognizes a relationship to the group of *Quadrula lachrymosa.* The extremely small size and similar form of the glochidia of these two species is another feature supporting this view.

Propagation.—No observations have been made upon natura infections. Experiments in propagation would be practicable in regions where the species is not uncommon. Scammon (1906) reports it abundant in Kansas and it is reported common in Indiana, and the closely allied species, *Q. fragosa* and *Q. nobilis,* are abundant in Arkansas.

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[a] I am indebted to Dr. Roy L. Moodie, of the University of Kansas, for this material.

THE MONKEY-FACE, *Quadrula metanevra* Rafinesque. [Pl. 1, fig. 4, 5.]

An odd shell of good luster and texture, but not of uniform thickness.

Habitat.—Larger streams and rivers, common in almost all stations. In my experience on the Mississippi it is found more often in the channel than on muddy bottom in still water.

Distribution.—Mississippi drainage area except its southern portion, extending to the Tennessee and Arkansas Rivers. (Simpson, 1900.)

Juvenile (pl. 1, fig. 6).—This stage was found on gravelly or sandy bottom in similar locations as the adult.

Glochidium (pl. v, fig. 31).—Form of the purse-shaped type with narrow hinge line. Dimensions: Height, 0.185 mm. to 0.2 mm.; length, 0.17 mm. to 0.176 mm. Breeding season, May, June, and July. This seems to be a short period and I suspect may be extended into August; however, examinations at the Fairport biological laboratory of some 89 specimens during August gave negative results.

Natural infection.—Infections with the glochidia of this mussel were found upon the gills of the sunfish, *Lepomis pallidus*, June 24, and of the sauger, *Stizostedion canadense*, July 26. The fish were taken at the edge of the river channel near mussel beds. Surber (1913) reports five infections on *Lepomis pallidus*. No decisive results in artificial infection with this species have been obtained, but the indications are that the sunfish, *L. pallidus*, may be infected successfully, and in the light of the information obtained regarding natural infections there should be no special difficulty in propagating this species.

THE NIGGERHEAD, *Quadrula ebena* (Lea). [Pl. 1, fig. 7, 8.]

This is a much-prized species because of the excellent luster, color, and texture of the shell, as well as its uniformity in thickness. Its habitat is both in mud and among rocks. Shells from a swift current have a better quality than those from water of little flow.

Distribution.—Mississippi drainage generally, except its western portion; Alabama and Tombigbee Rivers; northeast Texas? (Simpson, 1900.)

Juvenile (pl. 1, fig. 9).—The juvenile of this species I have taken only four times. Its scarcity in the collections is surprising when the abundance of the adult shell is considered. It seems probable that its habitat is on a pebbly bottom on which a dredge can scarcely pick up small material. Again, its color and shape are such as to make it difficult to find.

Glochidium (pl. v, fig. 30).—Gravid females with glochidia are reported from May until August. In 1912 the first found were 13 out of 85 examined on June 17, the latest 3 out of 66 examined on September 3. The spring of 1912 was late, which may have had the effect of delaying the breeding season.

All four gills are marsupial. The eggs are pink, giving this color to the gills. As development proceeds the embryos lose the color; but if, as is often the case, there are unfertilized eggs, the color remains until the eggs are discharged with the glochidia.

Form: Suborbicular; the outline as seen in side view is subsemicircular. (Pl. v, fig. 30.)

Dimensions: Height, 0.148 mm. to 0.15 mm.; length, 0.153 mm. to 0.16 mm. The dimensions of this shell are so near those of *Q. trigona* and *Q. solida* that one is obliged to rely chiefly on the form to distinguish them.

Natural infection.—In seeking the natural host for this species the investigation was begun early in the spring; although infections at this time seemed improbable, it was necessary to determine whether any infections could be carried over winter. The results, so far as this species of mussel is concerned, were negative; but a common infection by another species was found in the sturgeon, *Scaphorhynchus platorhynchus*, early in April soon after the ice broke up. Material was obtained by seining and trammel nets as well as by fyke or wing nets and lines. Many natural infections of various species were found during the spring, but the first evidence of any infection resembling the glochidium of *Q. ebena* was obtained June 21 on *Micropterus salmoides*. This was a single glochidium; similar single infections were found in June on *Pomoxis sparoides*, and one August 9 on *Pomoxis sparoides*, and four the same date on *Pomoxis annularis*.[a]

With this limited evidence as a guide, experiments in artificial infection were tried upon the three species named. The tests, although giving some results of interest, did not indicate that the natural host had been found. A discussion of the results will be found under the next topic.

On August 13, while out with the station seining crew engaged in mussel propagation, Mr. T. Surber secured a specimen of the blue herring, *Pomolobus chrysochloris*, heavily infected with glochidia. These, upon examination, were determined to be *Q. ebena*. This was the first specimen of this species of fish known to have been taken this season during the breeding period of the niggerhead. Earlier in the spring, May 16, a specimen was brought to me which proved to be heavily infected, but not with the niggerhead.

[a] The glochidia of *Q. ebena*, *Q. trigona*, and *Q. solida*, as will be seen by reference to the figures, do not differ greatly in appearance. This makes certain identifications difficult in some infections. (See *Q. plicata*, under natural infections, p. 27.)

Since finding this natural infection by the niggerhead, Mr. Surber has given special attention to the investigation of the infections by this mussel on the blue herring. (See Surber, 1913.)

The number of glochidia on a single fish is remarkable, some 3,700 being found on one, well encysted and giving evidence of maturing on the host. This, together with the relatively large number of infected fish taken, seems to fix this species as the natural host of the niggerhead.

The cases of infection observed on the black bass and crappies are probably either accidental infections which would not mature or they are the very similar glochidia of the pig-toe, *Q. trigona*, or the much less common *Q. solida*. In these three species the glochidia are so much alike that they can not easily be distinguished when embedded in the tissues of the host, especially when their number is limited. The implantation upon this fish may be at any point on the gill filaments, but shows a tendency to distribution on the tips. The filaments are so small that several are involved in a cyst, which is usually large for the size of the glochidium, as observed in artificial infections with this glochidium on other species of fish. (See artificial infection, p. 20.)

Several glochidia occur in a common or compound cyst where they happen to attach closely. A peculiarity observable in many preparations is the presence of spaces in the cysts apparently once occupied by a glochidium. Adjacent to or near these may be glochidia. Surber (1913) has interpreted these as cases of migration of the glochidia. This, if the correct interpretation, is a condition not previously observed. I am not yet convinced that there is any migration except that necessary in escaping from the cysts, as examples may be seen where the glochidium has a well-defined sheath in what I understand Surber would consider the second position.

Infections on the blue herring during the remaining season were found most abundant in August, falling off in number in September, the latest being September 24 to 26, when 2 out of 9 were found infected. My latest record for gravid niggerheads is September 3, 3 gravid out of 63 examined. The difference of 23 days between September 3, the last record for the gravid mussel, and the 26th, the last for infected fish, as a rough indication of length of the parasitic period, would signify that in this case it is longer than in the case of the warty-back, *Q. pustulosa*.

Reference to a specimen of this fish taken on June 18, 1910, by H. W. Clark, revealed natural infection with the niggerhead. This is the earliest season date that I know for an infection, but corresponds with our records of 5 gravid mussels on May 31 and 13 on June 17.

In the carrying of mussels by the herring we have an interesting example of a fish reported from salt water and possibly anadromous acting as a host for fresh-water mussels. In this case it seems probable that the mussels are attached during the stay only of the fish in fresh water; however, it supports the opinion of Simpson (1899, p. 282) that the presence of fresh-water mussels of the same species in parallel coastal streams can be explained by their being distributed by fish which are free to pass from the mouth of one river in the ocean to the mouth of another. (See also White, 1905.)

The blue herring seems not commonly to have any commercial use, at least in this region, though it has been reported as being used for food in the South. Although it has no recognized commercial value in the North, its really great value becomes apparent as the host of the most sought-after fresh-water shell. I have found the herring infected by another species of mussel, which observation is of interest as it shows that this fish is not the individual host of the niggerhead. The range of the herring is reported (Jordan and Gilbert, 1882, p. 266) as the Gulf of Mexico and the Mississippi Valley, abundant and resident in all the larger streams and introduced through the canals into Lake Erie and Lake Michigan. Twenty-six years later, Forbes and Richardson (1908) report it not common in Illinois. As the fishermen on the Mississippi in this vicinity do not seem familiar with it and make rather few catches, and there are reports of its having been abundant, it looks as if the fish were much less common at this point than formerly. There is this consideration, however, which would account for its escaping attention: It is a gamey fish requiring special means for its capture, and not being sought after, it may be more common than is apparent. The distribution of the fish corresponds with that of the mussel and it would be interesting to find any extension of the range of the niggerhead through the reported access of *Pomolobus chrysochloris* to the waters of Lake Erie and Lake Michigan. It may be, however, that the niggerhead, because of its natural habitat in swiftly flowing streams, could not thrive under lake conditions.

Artificial infection. Artificial infection was not undertaken until a systematic search had been made for the natural host. Up until the middle of August, as I have shown in the discussion of the natural host, the only evidence secured was the finding of four infections on the following species: Black bass, *Micropterus salmoides;* black crappie, *Pomoxis sparoides;* white crappie, *Pomoxis annularis.* There were only one to four glochidia in each infection, therefore they were not as conclusive as could be desired.

As experiments with the niggerhead had been tried by other workers upon these species of fish without success, I went to work on the assumption that success had not been attained in these cases because

of unsuitable conditions in artificial infection. Some indication that this was the case was soon obtained. The glochidia would attach in some instances and not in others. It is of course necessary to imitate natural conditions as closely as possible as to temperature, aeration, light, etc. The results were more favorable when the sun was out than during cool, cloudy weather and apparently better in sunlight than in shade. It was found important to infect as soon as possible the same day after securing the gravid mussels, as this species will abort glochidia soon after capture. The cause is supposed to be that the lack of aeration due to confinement causes the animals to expel the glochidia which must tend to interfere with respiration. The small degree of special differentiation required to form a marsupium and the presence of the glochidia in all four gills of the *Quadrulas* undoubtedly contribute to this.

Infection and encystment of the glochidia were obtained. (Pl. III, fig. 24.) The latter was even observed under the microscope upon filaments severed from the gill and immersed in physiological salt solution. In one case observed the glochidium was completely covered by the encystment in four hours.

In the case of the fish left in tanks and aquaria the glochidia, although well encysted, were shed in from one to three days in all cases. The longest retention was found in the black bass. The cysts in these infections were exceedingly large, the excessive hypertrophy apparently being due to excessive stimulation. (See fig. 24.)

In one instance the fish were immersed in a salt bath (NaCl, 10 per cent) before introducing them to the container holding the glochidia. This resulted in more certain and rapid infection than usual in all species experimented upon, but the infection was no more persistent. The significance of the results in this experiment I will take up in the general discussion.

After the completion of a number of such experiments the discovery was made, as previously mentioned, of infections in large numbers on the blue herring, indicating it as the host fish for the niggerhead. This gave an explanation of the inconclusive results already attained, but, on the other hand, it did not offer ready means for the application of artificial infection. The host in this case is a fish which offers great difficulties to the methods at present employed in artificial propagation, in that it is rarely taken here and is difficult to retain in a living condition long enough to successfully subject it to infection. In order to find how to do this, it will probably be necessary to experiment in localities where both the fish and mussel are abundant. If possible to capture in pound nets or traps or by careful handling when seined, they could be infected without removal from the water. As the mussel is a species found in the larger rivers, inclosures would have to be made in a body of water having a current.

Since the fish is very active, suitable nets must be used to prevent injury. Trammel or gill nets, or seines of unsuitable mesh, would be fatal.

A satisfactory completion of the investigation of the parasitic stage in *Q. ebena* will probably be greatly aided by gaining more thorough knowledge of the fish's habits. This information will, of course, aid also in determining suitable measures for insuring the increase of the mussel.

Since some mussels, as the mucket, *Lampsilis ligamentina*, have been successfully carried through on more than one species of fish, the possibility of finding some more practical host in this case has been kept in mind. I am of the opinion that the experiments already conducted have been sufficiently thorough to demonstrate that the species so far tried are unsuitable. Chances for success would be looked for in closely related species. The only really common species in this locality answering these requirements is the gizzard shad, *Dorosoma cepedianum* (*Le Sueur*). Unfortunately this fish, like *Pomolobus*, is not readily kept alive; but the difficulties may not be insuperable. I have seen it kept alive several hours in the laboratory during the winter and have no doubt it could be kept in ponds, as it is found alive in bayous isolated from the river. As it has not yet, however, been found to carry mussels upon the gills, the probabilities of success are quite uncertain.

Three species of shad are found in the Mississippi. These are more closely related to *Pomolobus*, but they are not reported common north of St. Louis. Surber (1913) suggests the interesting experiment of infecting the species of herring to be found in the rivers of the Atlantic coast. This might be successful if tried in rivers containing considerable lime in solution, as is the case in the rivers in which the niggerhead thrives.

Propagation.—There is probably no shell for which there is a larger demand at present and its uses might be greatly increased. From the results already attained in the investigation of the life history of the niggerhead, propagation might be undertaken at once, provided it were done in a way that would permit of definitely ascertaining results. Whether the herring can be caught in sufficient numbers to make such operations practicable is a question, but reports would indicate that they can be in some localities. However, operations upon a large scale are hardly to be recommended before a demonstration of artificial infection and the completion of the parasitic period has been observed.

The remarkably full infection of this species in nature indicate that under natural conditions propagation of this mussel will take care of itself. Thus recommendations of measures for preventing the depletion of the niggerhead would be along the line of protection to the

herring as the host fish. The cause for the increasing scarcity of the herring seems not to be due to capture in large numbers, as the fish is not commonly used for food throughout its range. It is more probable that it is due to artificial conditions, such as the obstruction of its natural migrations by dams and the introduction into the rivers of nonoxygenated sewage and the injurious wastes of manufacturing plants and the like.

Quadrula solida (Lea). [Pl. VI, fig. 46, 47.]

Quadrula solida closely resembles *Q. ebena*. I have investigated this species only so far as to make some observations upon its breeding. I found gravid females May 31 and July 23. In one specimen glochidia were present in both inner and outer gills; in the other cases only the outer gills were charged. Glochidia were found mature on both the dates mentioned. The glochidium (pl. V, fig. 34) has the subsemicircular form slightly more rounded than *Q. ebena*.

Dimensions: Height, 0.145 mm. to 0.16 mm.; length, 0.155 mm. to 0.160 mm. See also Surber (1912), to whom the material was referred for description. I have found no natural infections that could with certainty be ascribed to this species. Mr. Surber reported a single glochidium on a *Pomolobus* infected with many of *Q. ebena*. It would not be surprising if they are found to have the same fish for host.

The Pig-toe, *Quadrula trigona* (Lea). [Pl. I, fig. 10, 11.]

The brilliant orange-colored flesh of the pig-toe is characteristic, although occasionally it is found yellow or white. The nacre is a beautiful silvery white, more or less iridescent; rarely the nacre is pink. In the manufacture of buttons it is less desirable than the niggerhead because of less uniform thickness.

Habitat.—In the larger rivers, on a muddy bottom in rather deep water.

Distribution.—Western New York to Minnesota, and Iowa, and Kansas to Texas, east to Mississippi and Tennessee. (Call, from Baker, 1898.)

Juvenile.—The juveniles were the second most abundant of the 27 species I have collected and first in abundance among the *Quadrulas*. They were taken on both mud and sand bottoms. I have found this species in the artificial ponds at Fairport, Iowa, introduced in the parasitic stage on fishes -the second of the river-inhabiting *Quadrulas* to be found under such conditions.

Glochidium (pl. V, fig. 33).—The breeding records of the Fairport biological station for the past three years give June, July, and August as months in which the glochidia of this species have been taken. I found seven mussels with early embryos of this species August 27 and 28, 1913. and one with mature glochidia on September 10, thus ex-

tending the known breeding period well on into September. In July I took a gravid example only 30 mm. in length; this surprisingly small size for breeding indicates the early attainment of the adult stage. The glochidial shell of this species seems thin and more delicate than in *Q. ebena*. The eggs are a pinkish red, the glochidia colorless, filling moderately all four gills. Unfertilized eggs were found with glochidia, so that gravid mussels have gills varying in color from a deep to a light shade, according to the number of eggs remaining undeveloped. The number of undeveloped eggs is surprisingly high, sometimes more than 75 per cent. The form of the glochidium is of the subsemicircular type (fig. 33).

Dimensions: Height, 0.136 mm. to 0.149 mm.; length, 0.136 mm. to 0.153 mm. The smaller size and straighter lines of the anterior and posterior edges of the shell should distinguish this glochidium from the similar glochidia of *Q. ebena* and *Q. solida*.

Natural infection.—The natural host for *Q. trigona* has not to my knowledge been determined with any satisfactory degree of certainty. I secured infections on *Pomoxis sparoides* August 2 and *Pomoxis annularis* August 9, observing in the first 2 and the second 4 glochidia which answer to the dimensions of *Q. trigona;* but as unmistakable preparations of these were not obtained it is not at present possible to state whether they may not be either *Quadrula solida* or *Q. ebena*. Since the host-fish for the latter has been pretty definitely determined to be *Pomolobus*, it might be excluded as a possibility here if it were not known that accidental and sporadic infections are possible on other than the usual host. A single case is reported as *Q. trigona* on the black crappie, *P. Sparoides*, by Surber (1913); he also reports an infection upon *Pomoxis annularis*, but thinks both of these may be accidental infections. Some evidence as to the natural host was obtained in the finding of the juvenile of this species in an artificial pond in which sunfish, crappie, and gizzard shad, *Dorosoma cepedianum*, had been kept. Since gizzard shad have not been found with gill infections, the evidence favors the sunfish and crappie in this instance. Further evidence was obtained in the successful implantation of the glochidia on the gills of the sunfish in artificial infection; this will be taken up in the next topic.

The character of the distribution of the juveniles of *Q. trigona* must be of some significance; it was found to be the most generally distributed of all species in explorations of the river bottom, from which it is a safe presumption that the host must be a common fish. To summarize the results, the evidence, though not conclusive, points to the sunfish and crappie as the hosts.

Artificial infection.—In my experiments with this mussel five species of fish were tested, *Micropterus salmoides*, *Lepomis pallidus*, *Eupomotis gibbosus*, *Pomoxis sparoides*, and *P. annularis*. Examina-

tion the second day showed many glochidia encysted upon the gills of the sunfish, but only one or two on the bass and crappie. The third day they were still in good condition on the sunfish, but all gone on the others. By the seventh day all were shed by the sunfish. Whether the parasitic period in this instance was completed I unfortunately did not succeed in determining. If it were, the period is a brief one and needs further testing. Experiments were conducted by T. Surber with this mussel at the Fairport biological station in 1910. The following fishes were used: *Micropterus salmoides*, *Pomoxis annularis*, *Aplodinotus grunniens*, and *Lepomis* (sp.?). No implantation at any point on or in the body was observed, but free (without encystment) glochidia were found in the intestine of *A. grunniens* 17½ hours after exposure. The results of my experiments point to gill infection as the normal method for this mussel and to good chances for success with *Lepomis pallidus*.

Propagation.—Propagation of this valuable mussel at present would probably have to be restricted to the introduction of the adult mussel in new territory. The success of this method can not be predicted with any degree of certainty until we know whether the host (presumably a fish) is found in the waters where introduction is attempted. A recent report of Wilson and Danglade (1912) recommends the introduction of this mussel into the rivers of Minnesota. Very practical work can undoubtedly be done along the line of extension of range of valuable species, but it would be obviously impractical to do this without a more certain knowledge than we have at present of the life history of this species. Take for example the case of the niggerhead mussel. So far as is known, it is dependent entirely upon the herring (*Pomolobus chrysochloris*) for propagation. Introduction into waters where this fish was absent would accordingly be certain of failure, as the mussels would be nonperpetuating. I have mentioned above the finding of many unfertilized eggs in the marsupia of these mussels. In the examination of hundreds of shells from various points in the region investigated I have found this state of things quite general. The result is that glochidia are difficult to obtain except in small numbers; under these circumstances artificial propagation would be quite impracticable.

THE BLUE-POINT, *Quadrula plicata* (Say). [Pl. II, fig. 17, 18.]

This form also bears the name of "three-ridge." It is at present one of the most-used shells in button manufacture.

Distribution.—Western New York to Arkansas and Iowa, Michigan to Alabama and Texas.

Habitat.—In the larger rivers, in rather deep water, generally on a muddy bottom (Baker, 1898).

Juvenile.—I have found this species with several others in the artificial ponds at the Fairport biological station. They have been

introduced, for the most part, probably in the parasitic stage on fish retained in the ponds. As the first example of the *Quadrula* group raised in captivity, it has interest and is something of a demonstration that they may be raised under such conditions. This was the fourth most abundant species in my collections from the river.[a]

Glochidium (pl. v, fig. 32).—The breeding records indicate that mature glochidia are to be found during June, July, and August. On June 26 I observed the spawning of this species. The mussel was marooned on a sand bar and only partly in the water, and the loose white mass of glochidia were collecting in a depression in the sand behind it. I suspect this was not perfectly normal spawning, since the mussel was being left by the receding water, and cases of abortion of glochidia are commonly observed in the *Quadrulas* when placed under conditions unfavorable for oxygenation in the gills. The glochidium (pl. v, fig. 32) is of the hookless type, subsemicircular, elongate, and white in color. It possesses a thread gland and larval thread like *Q. heros*, and probably the same will be found in all the other members of the Crenodonta group as limited by Simpson (1900). The gland is somewhat different in appearance from that in *Q. heros*. The turns or loops of the spiral are of about the same number, but a small portion of what may be designated the distal end, becomes abruptly two to three times broader than the remainder. This larger portion begins at the posterior end of the hinge line and on reaching the anterior side of the adductor muscle curves in close to its ventral and posterior side. The contents of this enlarged portion is the coiled hyaline thread secreted by the gland, in a less condensed state than at the time of its emergence from the external pore, which lies on the posterior side of the adductor muscle.

The dimensions of the glochidium are: Height, 0.195 mm. to 0.215 mm.; length, 0.185 mm. to 0.200 mm.

Natural infection.—Five examples of natural infection with this species were obtained during June, July, and August. The fish were all crappies, both *Pomoxis annularis* and *sparoides* and were caught chiefly in the channel of the Mississippi on or near mussel beds where *Q. plicata* was abundant. Surber (1913) reports two cases, one on *S. canadense* and one on *P. annularis*, both for July 20. In determining natural infection of this species it is necessary to distinguish it from the glochidium of the "spike" mussel, *Unio gibbosus* (Barnes), as the latter has a similar form and dimensions, and it apparently infects some of the same species of fish. Typical glochidia differ in the following respects:

The dimensions in *U. gibbosus* are: Height, 0.208 mm. to 0.220 mm.; length, 0.190 mm. to 0.208 mm. The hinge line is proportionately

[a] I have received two juveniles of this species about 5 mm. in length, possessing a well-defined byssus. This material was collected in Lake Peppin by Mr. A. F. Shira.

longer and the thread gland curves in from the ventral edge of the right valve in *U. gibbosus*. In *Q. plicata* the ventral loops follow a peripheral course (see fig. 32). Unfortunately, this character is difficult to distinguish in glochidia which are imbedded in the tissues of a fish. Again, since the gland is an embryonic organ, it does not persist long after metamorphosis commences in tissues of the host. In natural infections it is not always possible to obtain an orientation of the specimens so as to obtain the most accurate measurements; especially is this the case when a fish carries only one or a few glochidia, when distinction between glochidia is made more difficult.

The number of infections determined as *U. gibbosus* were as follows: Black and white crappies, 5; yellow cat (*Leptops olivaris*), 1; Sauger (*Stizostedion canadense*), 1. In addition to these, I have records of three infections on the black bass (*Micropterus salmoides*) which belong to one of these species but which I am at present obliged to consider as doubtful.

Summarizing the results, the chief hosts for *Q. plicata* are indicated as the crappie, *Pomoxis annularis* and *Pomoxis sparoides*, with the sauger and black bass as occasional possible hosts. The reported (Lefevre and Curtis, 1912) successful artificial infection of *Micropterus salmoides* with *Q. plicata* would warrant the expectation of finding this fish infected in nature.

The presence of an embryonic thread suggests the possibility of fin infection from analogy with forms that possess that organ. The small size of the glochidium and lack of color would make them more difficult to detect than the fin-infecting glochidia of the *Anodontas*.

Artificial infection.—The artificial infection with this species which I have just mentioned as having been made by Lefevre and Curtis (1912) was the first reported and the only successful infection with *Quadrula* mussels so far as known to me. The fish, black bass, *Micropterus salmoides*, were infected August 5, 1908, exposed 30 minutes to infection, and young mussels liberated on August 17, giving a parasitic period of 12 days in water of 24.4° C. average temperature.

I have experimentally infected the following fish with this species: White crappie, *Pomoxis annularis;* black crappie, *P. sparoides;* yellow perch, *Perca flavescens;* sunfish, *Lepomis pallidus;* bullhead, *Ameiurus;* flathead catfish, *Leptops olivaris;* channel cat, *Ictalurus punctatus;* quillback, *Carpiodes velifer*. The first four named proved suitable as carriers of this species; the young mussels were carried through the metamorphosis in large numbers, and I was able to secure specimens of the young juveniles alive on the bottom of the aquaria in which the fish were retained. In the sunfish a large number were apparently shed prematurely, while a few were carried through to maturity. The bullheads carried a few for the full time, but on the

fins and not the gills. The remaining species shed the glochidia in from one to two days.

In the successful cases the period of parasitism varied from 8 to 11 days, the water temperature averaging approximately 76° F. The last to mature seemed to be at the tips of the filaments, thus indicating that the position was an important factor in determining the parasitic period. The young mussels on leaving the fish show no appreciable development of shell; thus they are very minute at this stage and probably a prey to many enemies.[a]

Propagation.—Several factors favor the artificial propagation of this species upon a practical scale. It is common and at present one of the most used shells in the button industry. It seems to be a form not narrowly restricted as to hosts and these are indicated to be among the commonest and most readily obtainable fishes. Although a river form, its habit as a dweller in stiller water and on a mud bottom makes it susceptible to propagation or control under conditions readily imitable in artificial lakes or ponds. A continuous water supply is desirable; my observation has been, however, that it will survive rather adverse conditions in this respect. I have collected many live specimens from a slough which had gone dry to the extent that only mud remained. Under these conditions the majority of the pond mussels, *Anodonta corpulenta*, had died. I would cite also the finding of this species accidentally introduced in the parasitic stage into an artificial pond at Fairport, Iowa. The pond had gone dry and I found a specimen still alive buried in mud barely moist. It is evident, I think, from these observations that the species is hardy, at least as regards some of the more common vicissitudes to which mussels are naturally subjected.

The Washboard, *Quadrula heros* Say. [Pl. II, fig. 14, 15.]

This is the largest and one of the most handsome of American fresh-water mussels. Its unusual size adapts it to special uses, and in some localities it has the reputation of being one of the best of pearl-bearing species.

Distribution.—Mississippi River system generally; Red River of the North; Tombigbee River, Ala.; southwest to Nuevo Leon, Mexico (Simpson, 1900).

Habitat.—It is found in large rivers in deep water and on muddy bottoms.

Juvenile (pl. II, fig. 13).—The juveniles are very handsome because of their elaborate shell sculpture. They were taken in the same locations as the adult, viz, in deep water on a mud bottom.

Glochidium (pl. V, fig. 35).—I obtained mature glochidia of *Q. heros* September 24, having taken early embryos August 24 and immature glochidia as early as August 28. During October, in

[a] See p. 12, footnote, regarding observations of the destruction of young *Q. pustulosa*.

observations covering two successive seasons, the mature glochidia were readily obtained, as the majority of adult females examined were gravid. An examination on November 7 of 55 individuals from the same mussel bed yielded no gravid specimens at all, and some 50 mussels in March and April yielded 1 gravid specimen only; this was found April 14, and contained immature glochidia, still surrounded by the vitelline membrane. All the information available indicates that the regular breeding season is during the autumn, chiefly October, with an extension into the winter months in some localities, but that the glochidia are not carried a long period in the gills as in the Lampsilinæ. Since all four gills are used as marsupia and greatly distended, a long breeding period would seem to be too great an interference with the breathing function of the gill.

The productivity of this form is enormous, a single average-sized individual in which I estimated the number gave one and a third million young. A count was made of a definite fraction of a marsupial chamber in a gill and the total computed from a count of these chambers for the four gills, account being taken of difference in size in the gills. Simpson (1899) quotes Lea as giving the number of young produced as 6,000,000. I have not seen the original of this statement by Lea, but find another (Lea, 1857, p. 40) in which he gives an estimate of 3,000,000 or 4,000,000 as the number produced; as he says "probably to the number of 3,000,000 or 4,000,000," he may not have made an actual computation. A specimen twice the size of the one I considered, which would be unusually large, would hardly have more than 3,000,000. From this I suspect that Lea's estimate is too high. Lefevre and Curtis (1912, p. 144) say in regard to the breeding period of this species that, finding young embryos in May, their observations are not in accord with those of Frierson (1904), who found glochidia in January and so concludes that *heros* is an exception to the genus *Quadrula* and not a summer breeder. Conner (1909) gives an observation of breeding in November. Surber (1912) figures an immature glochidium, giving dimensions which correspond closely with the mature embryo, together with observations on the breeding season. Simpson (1900, p. 776) is of the opinion, since he has seen so few gravid specimens, that the breeding of these species is only at long intervals. It is apparent from the above references that the observations upon the breeding of this species have been quite limited and I know of no description of mature glochidia, with the exception of Lea's (1857, p. 46). In his description there is no reference to the time of breeding and he has omitted anatomical features that are distinctive. He says:

Unio multiplicatus (synonym for *Q. heros*) Lea, figure 3. Pouch shape; dorsal line long; side margins gently curved, basal margin slightly rounded; color clear white. Has no hooks.

The above is sufficiently accurate as to the features described but is not enough to identify the glochidium, since there are so many forms answering this description. I think the following will serve to distinguish it:

Dimensions: Height, 0.316 mm. to 0.340 mm.; length, 0.250 mm. to 0.260 mm. The right valve contains a large and conspicuous thread gland; this is in the form of a spiral rod (pl. 3, fig. 21) tapering at each end, and having about two turns about the adductor muscle. As compared with this gland in *Anodontas*, it is more conspicuous because of its greater width and its being possibly more highly refractive to light. The inconspicuous tapered extremities lie near the ventral side of the adductor muscle and one of them opens to the mantle cavity; from this opening the larval thread extends. The latter is of considerable length and lies coiled in the mantle chamber. It consists of a delicate hyaline thread which becomes readily extended when the glochidia are extruded from the parent gills. The presence of a thread gland has not been previously reported for the *Quadrula* group, I believe, and only in the *Anodontas* and the *Unios* (as listed by Ortmann, 1912). I find it present in *Pleurobema æsopa* and also in *Unio gibbosus*, for which, with the closely related forms, Ortmann has created the new genus *Elliptio*.

Natural infection.—When the investigation of the breeding of this mussel was undertaken very few data were available; in fact, the published accounts, as I have shown, indicated considerable uncertainty about the breeding period. I was fortunate in finding gravid mussels with active glochidia in considerable abundance and suitable for experimentation. This situation led me to accept the opportunity presented before I was able to investigate sufficiently the problem as to the natural host. I subjected a number of species of fish to infection, obtaining quite definite results. The following species carried the glochidia successfully on the gills or the fins: The sunfish, *Lepomis pallidus* (pl. IV, fig. 26*b*); the catfishes, *Ictalurus punctatus* and *Ameiurus melas;* and the drum, *Aplodinotus grunniens*. Some months after these experiments were made Mr. T. Surber, in examination of Arkansas fishes taken in January, reported several natural infections by this species on the fins of a sheepshead, *Aplodinotus grunniens*, but none on the gills. More recently I have had the opportunity of examining a number of fish taken in the Mississippi at three different stations. Among these I found infected by the larva of *Q. heros* five species of fish and the batrachian, *Necturus maculosus*. These observations are shown in detail in table 2.

The infections upon *Necturus* were none of them encysted, even after attachment for a known period of several days, which leads me to believe that the mussel is incapable of development upon this host.[a]

[a] Incidentally the observation may be of interest of a larval mussel of another species abundant upon *Necturus* completely encysted and passing through its metamorphosis on this animal.

TABLE 2.—NATURAL HOST OF FRESH-WATER MUSSEL QUADRULA HEROS.

Name of host.	Date.	Locality.	Number of glochidia.		Development.
			Gill.	Fin.	
Necturus maculosus	Oct. 20	Moline, Ill.	Few.		Not encysted.
Do	do	do	Few.		Do.
Do	Oct. 22	do	Few.		Do.
Dorosoma cepedianum	do	do		25	Do.
Pomoxis annularis	do	do		22	Do.
Dorosoma cepedianum	Oct. 24	do		48	Completely encysted.
Do	do	do		17	Do.
Do	do	do		2	Do.
Pomoxis annularis	do	do		1	Undetermined.
Do	do	do		1	Do.
Roccus chrysops	Oct. 25	Fairport, Iowa	3		Encysted.
Amia calva	Oct. 28	Moline, Ill.	1		Do.
Necturus maculosus	do	do	Many.		Not encysted.
Leptops olivaris	Nov. 7	Hampton, Ill.	2		Deeply encysted.

The results of the artificial infection experiments and the observations upon natural infections would indicate that this mussel may carry out its development upon both the gills and fins of a number of species of fish. In the natural infections it will be noted that the infection of the fins was more common.

This is an interesting case of a hookless glochidium adopting partially the fin-infection habit which is found in the *Anodontas*. It has other characters in common with this group in the large size of the glochidium, in the presence of the large thread gland, and in the winter (though probably not long period or bradytictic) breeding habit. The opinion of Simpson (1900, p. 766, footnotes) that this species breeds only at long intervals was based upon the absence of observations of gravid specimens. I think this scarcity of records may be ascribed partly to the following causes: The breeding season is at the time of year when less collecting is being carried on, as well as at a different season from that of related forms. Again, gravid mussels abort the glochidia so that the evidence is liable to be lost unless observed when the mussels are first removed from the water. I think the assumption that they breed annually is safe until more definite evidence to the contrary is found.

Artificial infection.—Mature glochidia suitable for infection were first obtained September 24, and subsequently other gravid mussels were obtained, apparently being not difficult to find. It was noticed that the glochidia had unusual vitality, it being possible to use the same lot day after day for more than a week. This is in marked contrast to the conditions I have encountered among other *Quadrulas*. It is possible that it may be associated with the lower temperatures at this season. Another feature of importance is the immense number of glochidia, which increases greatly the ease of manipulations.

Some 10 species of fish were subjected to infection in six different lots, according to the usual method. The results of these experiments are summarized in table 3.

TABLE 3.—ARTIFICIAL INFECTION OF QUADRULA HEROS SAY.

Date.	Experiments.	Fish.	No. of fish.	Glochidium retained until—	Period on fish.	Encysted.	Position.
Sept. 25	30–34	P. annularis	7	Sept. 26	1 day	No	Gill.
25	30–34	P. sparoides	9	Oct. 1	6 days	Yes	Do.
Oct. 1	30–34	R. chrysops	4	Oct. 6	5 days	Yes	Do.
Sept. 27	30–34	M. salmoides	4	Oct. 8	11 days	Yes	Do.
27	30–32	I. punctatus	7	Feb. 7	4 months 11 days [a]	Yes	Fin.
27	30–35	A. melas	2	Feb. 11	4 months 15 days [a]	Yes	Gill and fin.
27	30–35	L. pallidus	8	Dec. 6 to Feb. 5	2 months 9 days to 4 months 9 days.	Yes	Gill.
25	30–34	S. canadense	5	Oct. 5	10 days	Yes	Do.
Oct. 25 to 7	30–35	A. grunniens	6	Apr. 18	6 months 11 days [a]	Yes	Fin.
1	34	C. difformis	1	(Died.)		Yes	Do.

[a] Glochidia remained upon the fish after the date observed.

It will be noted that both gill and fin infection persisted more than four months on the catfishes, *Ictalurus punctatus* and *Ameiurus melas;* gill infections remained upon the sunfish over two months (pl. IV, fig. 26*b*). In these cases evidence of development was found, but not determined for the shorter periods of 11 days or less. In *Aplodinotus*, fin infections remained till April, more than six months, and showed considerable development at the time of examination.

The indications are that infection takes place chiefly during the autumn, possibly to some extent in winter and early spring, and that the young mussel leaves the host when the water becomes warmer in the later spring. The readiness with which the glochidia become attached to fish in the autumn would indicate that this is a natural time for infection, although for some long-period breeders (*Anodonta*) it is claimed that development proceeds during the winter before leaving the parent gill (Lillie, 1895). Lillie states that the glochidia are carried through the winter and are extruded finally in the spring: the species to which he refers is *Anodonta cataracta*. Lefevre and Curtis say that *Anodontas* have mature glochidia early in October. An experiment performed at the Fairport laboratory by Messrs. Clark and Surber September 26, 1910, with *A. corpulenta* resulted in attachment of glochidia upon fish, but temporarily only. From these citations it would seem that there is difference of observation as to the maturity of glochidia in the genus *Anodonta*. There may be a considerable difference as to date of maturity for different species of the genus, as is the case in the genus *Quadrula*.

The difference in duration of the period of attachment to fishes in the different hosts is to be noted. I am not at all certain of the explanation. If, as reported by Schierholz (1888) and Harms (1907–1909), the duration of the parasitic period varies inversely as the temperature of the water, that would not explain the liberation of glochidia from sunfish in midwinter. One must assume a difference of rate for different hosts or that development was incomplete in the case of the shorter periods.

The possibility of implantation upon both gills and fins of the host seems to be more liable to occur in this species than in any other of which I know having hookless glochidia. This habit might naturally be correlated with the large size, which would enable the glochidium to become attached more readily to the exterior of a fish, where places for attachment are coarser than on the gills. This character should be of advantage in artificial infection, through more diffuse distribution on the fish and on less vital parts, permitting a higher optimum infection. In the present experiments the largest number of glochidia carried through four months was 28;[a] this, however, should not be considered any criterion of possibilities, since the parasitic period in this case is probably an unusually long one. In general for the long-period breeders it is probably more economical, other things being equal, to infect in the spring, thus securing a shorter and more certain development.

The infection of the fins in the catfish calls attention to a difference in suitability to infection between such a fleshy fin and the membraneous type of the Centrarchidæ, which group has been found so favorable for gill infections.

The encystment of the glochidia of *Q. heros* (see pl. IV, fig. 26*b*) indicates a less vigorous reaction of the hosts tissues than, for example, in the niggerhead; in that the cysts are comparatively thin.

Propagation.—The very large size of *Q. heros* and the thickness of the shell give possibilities of use which are found in no other mussel. At the present time it is, according to manufacturers, with the mucket, *L. ligamentina*, and the three-ridge. *Q. plicata*, one of the three chief shells used in the button industry, possibly taking first place for large buttons; in quality it is considered second grade, but varies with locality. From the results of this investigation it is shown to be one of the most favorable among the *Quadrulas* for artificial propagation. The reasons for this are as follows: It is a fall or winter breeder, thus not being limited to a brief summer breeding period at a season when it is more difficult to deal with live fish and at a time when the other *Quadrulas* are breeding. It has at least three host fish and probably more upon which it can be propagated. The tremendous number of glochidia produced and their great vitality are features that increase the chances of success in artificial propagation. Its natural habitat is more easily imitated under artificial conditions than that of species which are restricted to river channels in that it is found in the more quiet waters of lagoons and lakes as well as in the open rivers. For a heavy shell it is a rapidly growing species.

[a] Through the winter of 1913–14 *Q. heros* was carried to maturity in large numbers (800 to 1,200 per fish) on the gills of the following: *Pomoxis annularis, P. sparoides, Lepomis pallidus, Apomotis cyanellus* and *Ameiurus* Sp., and in smaller numbers on the fins of the following: *A. grunniens, Ictalurus punctatus, Ameiurus* Sp.

Natural hosts of mussels of Quadrula group.—Natural infections of fish by mussels of the *Quadrula* group were found as follows, the figures representing the number of fish:

Warty-back (*Q. pustulosa*), on—
Yellow catfish (*Leptops olivaris*), 1.
Spotted catfish (*Ictalurus punctatus*), 9.
Crappie (*P. annularis*), 1, reported by Surber, 1913.
Pimple-back (*Q. pustulata*), on—
Crappie (*P. annularis*), 1, reported by Surber, 1913.
Monkey-face (*Q. metanevra*), on—
Bluegill sunfish (*Lepomis pallidus*), 1; 5 reported by Surber, 1913.
Blue sunfish (*Apomotis cyanellus*), 1, reported by Surber, 1913.
Sauger (*S. canadense*), 1.
Niggerhead (*Q. ebena*), on—
Large-mouth black bass (*M. salmoides*), 1(?).
Skipjack (*Pomolobus chrysochloris*), 11, reported by Surber, 1913.
Q. solida, on—
Bluegill sunfish (*L. pallidus*), 2, reported by Surber, 1913.
Pig-toe (*Q. trigona*), on—
Pomoxis sp?, 1.
Crappie (*P. annularis*), 1.
Strawberry bass (*P. sparoides*), 1, 1(?) reported by Surber, 1913.
Blue-point (*Q. plicata*), on—
Large-mouth black bass (*M. salmoides*), 3(?).
Pomoxis sp.?, 2.
Crappie (*P. annularis*), 2; 1 reported by Surber, 1913.
Strawberry bass (*P. sparoides*), 1.
Sauger (*S. canadense*), 1.
Washboard (*Q. heros*), on—
Fresh-water drum (*A. grunniens*), 1, reported by Surber, 1913.
Eel (*Anguilla chrysypa*), 1, reported by Surber, 1913.
See also table 2.

TABLE 4.—COLLECTION OF JUVENILE QUADRULAS, SEASON OF 1912.

No. of station.	Name.	Date.	Dredge hauls.	Depth.	Bottom.	Q. pustulosa.	Q. pustulata	Q. granifera.	Q. lachrymosa.	Q. metanevra.	Q. ebenus.	Q. solida.	Q. trigona.	Q. plicata.	Q. heros
1	Iowa Shute.....	June 20	9	3–6	Sand and gravel.	3	....	...	...	....	...	...	3	1	...
2	Smiths Cove to Pine Creek.	June 22	15	4–8	Varied(see hauls)	2	....	...	...	1	...	...	...	...	...
3	Sand bar above Smiths Creek.	June 25	0	.....	Sand silt.....	0	8	...	...	....	...	...	3	1	...
4	.....do.....	June 26 June 28	0	0–½	.....do.....	0	2	...	...	....	...	...	3	2	...
5	Pine Creek.....	July 10	4	2–8	1, mud; 2, 3, and 4, mud and gravel.	4	....	...	...	1	1	...	4	3	...
6	Pine Creek to Buffalo.	July 12	11	2+	1–6 gravel; 7–11, mud and gravel.	5	1	2	...	1	1	...	17	15	...
7	Montpelier.....	July 15	5	Varied.	Varied(see hauls)	1	....	1	...	....	...	...	2	....	...
8	Barrs Landing....	July 17	2	2–5	Gravel and mud.	11	....	...	1	2	...	...	16	6	...
9	Wagglers Landing	July 29	5	3–5	Gravel and sand.	12	....	1	...	8	...	...	7	5	[a]1
10	Moline.....	Sept. 24	4	2–4	Sand and mud..	0	....	...	...	....	1	...	1	5	1+[a]3
11	.....do.....	Sept. 26	5	2–4	Mud.....	1	1	...	...	....	1	...	3	10	...
12	Davis Point.....	Dec. 14 Dec. 23 Dec. 24	0	⅛–4	Pebbles.....	0	....	...	...	....	...	...	....	....	...
						39	12	4	1	13	4	0	59	48	5

[a] Over 20 mm. and under 65 mm.

GENERAL DISCUSSION.

In the investigation of the specific problem of propagating the *Quadrulas* some results have been attained which are of general application probably to all the Unionidæ. Also observations have been made incidentally upon other species which, as they have a bearing on the present problem, require discussion.

REPRODUCTION AND EMBRYONIC STAGES.

As practical propagation of the Unionidæ is only indirectly concerned with the embryonic stages, I have not dealt with these in the body of this paper. My observations upon these stages have been very limited and incidental only to other studies, but as the *Quadrulas* have had little attention some of these may be worth mentioning. Reproduction among the *Quadrulas* seems to be essentially as reported in other Unionidæ (Rabl, 1876; Schierholz, 1888; Latter, 1891; Lillie, 1895). The sexes are separate so far as known. The gonads occupy a considerable portion of the visceral mass among the coils of the intestine. The eggs upon extrusion from the genital apertures pass into the suprabranchial chambers of the inner gills, passing from there to the cloaca and then back through the suprabranchial chambers to the gills. They are probably fertilized during transition to the gills by sperms introduced with the respiratory current. I have observed ovulation in *Quadrula ebena* and remarked the exceedingly fine stream of eggs issuing singly and covered by mucous envelope; the passage to the gills was not observed, but it would seem strange in these forms which carry embryos in all four gills that the eggs should not go directly into the inner gills, as they must pass the openings of the water tubes.

Contributions to a knowledge of the development from the eggs to the glochidial stage among Unionidæ have been made by Flemming (1875), Schierholz (1878, 1888), Goette (1891), and these stages have been completely described for *Unio complanata* and *Anodonta cataracta* by Lillie (1895).

While making examinations for breeding periods I was much astonished to note the slowness of division processes. The eggs of *Q. ebena* examined in the morning of May 31 seemed to be all in the one-celled stage; in the afternoon two-celled stages were present. The second day segmentation had advanced to the four- and eight-celled stages only, and the fourth day 16-celled stages predominated. Since making these observations I have read Lillie's (1895) paper and see that he has commented upon the phenomenally slow segmentation in the forms which he examined, *Unio complanata* and *Anodonta cataracta*, contrasting it with the rapid development in marine lamellibranchs.

PARASITISM.

There are questions associated with the parasitism of fresh-water mussels which have previously had little discussion. Obviously the basis for a consideration of these must be upon observation of natural infections. I wish to discuss these under the following heads: Restricted infection, susceptibility and immunity, frequency of infection, extent of individual infection, conditions of infection in nature, etc.

Restricted infection.—The existence of specific or narrowly restricted parasitism in the case of some mussels I believe I have demonstrated in the case of *Q. pustulosa* upon the channel cat, *Ictalurus punctatus* (Howard, 1912). A similar case is that of the niggerhead upon *Pomolobus chrysochloris* (Surber, 1913). These are not surprising, since it is common, especially among animals, for a certain species of parasite to be restricted to a given species or genus of hosts, as *Goniodes stylifer*, the louse infesting the turkey, and *Trichodectes scalaris* upon the ox. If by accident they come in contact with some other animal they do not remain. Why? The supposition is that the reaction of the blood or something about the foreign hosts is unfavorable to them; in anthropomorphic language, "they do not like it."

To what extent this principle of limited parasitism extends among mussels is still to be determined. It seems obvious, however, that a solution of this question is logically to be sought from a study of natural infections.

The method of determining the host by artificial infection has proved practicable in the experiments reported by Lefevre and Curtis (1912), but in these cases the mussels were parasitic upon common and easily obtainable fish. The chief commercial species employed was the mucket, *Lampsilis ligamentina*, and the fish successfully infected were the sunfish, *Apomotis cyanellus*, and the black bass, *Micropterus salmoides*. In the experiments at the Fairport biological laboratory black bass, sunfish, and crappies were infected successfully; the pike, *Esox lucius*, and the perch, *Perca flavescens*, were reported doubtful. From these results it would seem that infection with the mucket is limited chiefly to the Centrarchidæ, a single family of fishes. The hooked glochidia of *Anodonta corpulenta* seem less restricted. I have seen these upon fish of the following families: Clupeidæ, Centrarchidæ, and Sciænidæ. A similar state of things is seen in the hookless external infecting glochidia of *Q. heros* successfully maintaining itself on the Sciænidæ, Siluridæ, and Centrarchidæ (the latter two observed in artificial infection).

Susceptibility and immunity.—The commonness of infections on some species of fish in nature might be called a sign of susceptibility

in those species. The drum or sheepshead, *Aplodinotus grunniens*, is found infected commonly with the glochidia of *Lampsilis lævissima*, *L. gracilis*, *L. alata*, *Plagiola donaciformis*, and others. The drum is a mussel-eating fish (see Forbes and Richardson, 1908), so that we have an explanation of the presence of the larva of these thin-shelled and so readily eaten mussels upon its gills. In the above example we have several species of mussels parasitic upon one species of fish. From many examinations of the channel catfish, *Ictalurus punctatus*, I have found only one species of mussel, viz, *Q. pustulosa;* this seems to be the other extreme.

The failure to obtain gill infection with certain species has been mentioned (see introduction). I have observed a similar immunity in examinations for natural infections on the gills of the gar pike, *Lepidosteus platostomus*, the dogfish, *Amia calva* Linnæus, and the suckers, the Catostomidæ. Upon obtaining fuller data such cases may perhaps prove to have their parasitic species, at present unknown. It is to be noted that these reported cases of immunity refer to gill infection and that the absence of these possibly does not preclude infection of fins. We have not found infections on the gills of the gizzard shad, *Dorosoma cepedianum*, but Mr. A. F. Shira has found the fins of this species infected.[a]

Lefevre and Curtis, in seeking an explanation of immunity, raise the question as to whether the factors are chiefly mechanical or are an histological response of the fish's tissues. In my opinion both of these operate, and there is still another factor, viz, the failure of glochidia to fasten when the appropriate host is not found. The histological response begins with the hypertrophy resulting in the formation of the cyst; this occurs in most cases whether the parasite is retained or not. If not, the cyst is shed by a process of desquamation of the external epithelium. I have observed this in gill infections only. A stream of water of not great force will remove the outer layers of epithelium of an infected gill about to shed the glochidia. Such a catarrhal reaction is presumably the result of the irritation set up by the glochidium. The question arises as to what prevents such a reaction in cases of successful implantation. Is it merely absence of immunity in the host, or does the glochidium supply an active agent in the nature of an anæsthetic to prevent the irritation that would be expected? Mr. Thaddeus Surber once called my attention to an apparent case of acquired immunity in some sunfishes which received glochidia upon the first infection but not the second. This is a matter that should be investigated, as the existence of such a possibility would prevent the use of fish more than once successfully in artificial propagation.

[a] Since writing this, I have found infections by *Q. heros* upon the fins of this species, also infections by other mussels upon the gills of the gar-pike and the dogfish. (See table 2.)

Some of the mechanical factors in immunity mentioned by Lefevre and Curtis were such as configuration of mouth parts, texture of gills, smallness of gill openings, and rapidity of fin movements. The third factor which I suggest, viz, failure of glochidia to react, was observed in experiments upon the niggerhead, *Q. ebena*, and the warty-back, *Q. pustulosa*. In the latter case the glochidia fastened readily upon the catfish, but not upon other species of fish upon which the glochidia of the mucket, *L. ligamentina*, will fasten readily. It is difficult to obtain any infection with the glochidia of the niggerhead upon the members of the Centrarchidæ; however, under certain circumstances (see the next topic) they will take hold so vigorously as to threaten overinfection. From such results it seems not improbable that the tissues or blood of the nonhost possess reactions in the nature of antibodies, precipitins, and other immunizing agents, such as those discovered in the higher vertebrates, while the glochidium is especially adapted to the reactions of the appropriate host.

Induced susceptibility.—I have already mentioned, in discussing the niggerhead, an experiment in which fish were immersed in a solution of common salt (10 per cent, by weight) before placing in the infecting tank, where it was shown that this treatment had the marked effect of causing rapid infection where previously it had been difficult to obtain. We have here possibly a suggestion that this reaction is related to the normal habit of the glochidium in responding to the presence of its natural host, the blue herring, a fish reported from salt water and possibly anadromous. However, one would assume that all perceptible traces of the more saline medium would be lost when the fish had passed through a few miles of fresh water. In my opinion, there is no causal connection here, since glochidia of many species show excitement in the presence of sodium chloride and other salts. This is due undoubtedly to the fact that their normal reaction is to chemical stimulation from the ions of protoplasmic salts diffused from the animal fluids of fishes' gills or bodies. As the glochidia did not remain upon the fish through the parasitic period, a probable explanation would be that the salt could have had only the effect of overcoming the inhibition of the glochidia to react.

The effects of the parasitism of the glochidium upon the host and the exact relations to the host at various stages in the developing mussel are matters the investigation of which should be productive of interesting results. Lefevre and Curtis (1912) record observations of the ingestion of portions of the host's tissues by the glochidium soon after implantation. It is a question whether the host continues to supply sustenance other than oxygen in forms like *Lampsilis ligamentina*, which show little or no increase in size. In forms like those of the *Proptera* (Ortmann) group, which increase to a considerable extent in the parasitic stage (see metamorphosis during the

parasitic stage), the host must furnish the material. In these cases I have observed ocular evidence of absorptive processes whose exact nature I hope to investigate later.

Frequency of infections.—To know the proportion of infected fish in nature is a matter of considerable importance. The expectation would be that it must, from the nature of the case, vary according to species, locality, season, abundance of mussels, source of the fish, and the like. The results I have given for the channel cat, *Ictalurus punctatus*, give an idea of the variation that occurs. We see that for this fish during the months of July and August, the breeding season for the warty-back *Q. pustulosa*, there were 17 infected fish out of 39 examined. The entire absence of infections in September from an examination of 98 fish is explained by the season, which was after the close of the breeding period for the mussel. The figures given by Surber (1913) of no infections out of 21 fish of this species examined in August, I can hardly explain unless it is that the fish were not taken near mussel beds, or that owing to the position of the glochidia they might be easily overlooked in living fish.

The drum or sheepshead, *Aplodinotus grunniens*, on account of the fact that it is the host for a large number of species, runs the chance of more frequent infections.

In a region where artificial infection has been carried on upon a large scale, it would be difficult to determine satisfactorily anything of this nature regarding the species employed in the operations; this difficulty has arisen in investigations at the Fairport biological laboratory, fish having several times been captured which had been without doubt artificially infected.

Extent of individual infections.—Certain species of fish commonly in nature carry a remarkably large number of glochidia; for example, the drum, *Aplodinotus grunniens*, and the herring, *Pomolobus chrysochloris*, have been found with thousands; but a small number seems more common. Heavy infections are difficult to explain, except upon the supposition that they take place at the time of extrusion from the mussel, or as the result of oft-repeated infections. This brings up the subject of the following topic.

Conditions of infection in nature.—I know of no observations of the infection of fish in nature. Latter (1891) found that he could produce a discharge of glochidia by gently striking the water in which anodons were lying and made further observations upon the emission of glochidia which, he seems to conclude, argue against the necessity of the presence of fish. I believe, however, they support the probability that the approach of fish is the normal stimulus in eliciting the emission of glochidia. The cases of heavy individual infection of fish found in the species mentioned above suggest that the glochidia must be extruded when the fish are in close proximity, otherwise the

glochidia would be too widely distributed to make heavy infection possible. We find the heaviest infections with glochidia of the niggerhead, which lives in swiftly flowing water. It would be quite reasonable to expect adaptations here comparable to those seen between insects and plants, not necessarily as elaborate as that between the rein-orchids *Habenaria* and fertilizing moths, but something of that nature would be equally advantageous to a species of mussel. The expected features in such a relation would be some attractive agent in the mussel, the perception by the latter of the fish's presence, and the reaction of extruding the glochidia. Mussel beds are known to offer attractions to fishes because of the associated life in their vicinity, such as worms, crustaceans, and the like. During the summer of 1912, Dr. W. P. Herrick called my attention to at least three instances of fish (sunfish in each case) being taken in his crates which contained live mussels. We have abundant evidence of attractions to some species of fish, e. g., catfish and sheepshead, in the food which the thin-shelled species of mussels supply (Forbes and Richardson, 1908, quoted above, and Kendall, 1910). This is a rather vicarious offering, and it is not known to be made by the heavier-shelled species among which we have found cases of narrowly restricted parasitism. It is among these that we would expect some special adaptations.

Type of infection.—In observations upon natural infections I have found that in general the hooked glochidia were to be found upon the fins and the hookless upon the gills, as has been reported by others, chiefly from artificial infection (Harms, 1909; Lefevre and Curtis, 1912). I find, however, there are some apparently constant exceptions. I have mentioned above the observations that the hookless glochidium of the washboard mussel, *Quadrula heros*, was found to be a fin-infecting species. Its considerable size apparently adapts it to this mode of infection. The presence of a larval thread also suggests a possible relation to this habit because of the presence of that organ in the fin-infecting hooked glochidia. In support of this is the recent discovery of fin infection in nature by the small hookless glochidium of *Unio gibbosus*, which has a larval thread.

I have rarely seen natural infections of gills by hooked glochidia; in two cases they were evidently unsuccessful, the glochidia having died, and were embedded in hypertrophied tissue at the base of the gills, apparently in process of shedding. The third and fourth instances were apparently successful infections of single glochidia, in one case on the heavy gills of a catfish, *Leptops olivarus*, and in the other on the sturgeon.

Another case was a heavy infection on the gills of *Pomolobus chrysochloris* by a glochidium which is hooked, but the hook is not

of the ordinary type in the Anodontinæ (see pl. IV, fig. 27). The hook has the character of a straight thong inside the apex of each valve. The glochidium has been identified as that of *Unio crassidens*.

The absence of evidence of natural infections from certain species of mussels and failure to obtain infections with them according to known methods has led to the search for them as internal parasites of fishes. My examination of the alimentary tract of fishes has given negative results entirely. Mr. T. Surber, after infecting with *Quadrula trigona*, found their glochidia in the intestine 17 hours later, but they were not encysted, and the supposition was that they were not established in any way.

Type of cysts. The type of cyst varies in different cases, and the question arises as to what are the factors that determine the form of a cyst. In artificial infections on several species of fish the cyst in each fish will vary in form as well as in distribution upon the gill in each species, and again infections with different species of mussel will vary in the same species of fish. That is, stimulus and reaction vary with the parasite and host. This is perhaps self-evident, and as a rule differences are not striking, but as there are occasional cases of marked peculiarity in cysts their consideration may be of interest. In the discussion of *Quadrula ebena* I have described the relatively large cysts. This holds for the natural host, *Pomolobus chrysochloris*, as well as for artificial infections on other species. The large glochidium of *Q. heros* has a relatively thin cyst in gill infections. In the case of *Q. pustulosa* the glochidium is usually quite deeply imbedded, but the cyst does not markedly change the contour of the gill filaments. This is due in part to the manner of implantation of the glochidium, it being usually attached to the edge of the broad filament in the catfish. There is commonly an inset of the cyst (pl. III, fig. 23) that seems peculiar to this form, but is not constant. Abnormal cysts of strange forms are occasionally found. I have figured one of these (pl. III, fig. 20), in which the hypertrophied tissue is more extensive than usual and prolonged into fingers or rays. In that shown in figure 20 the stimulation of the glochidia implanted at the base of the folds of the filament affected apparently the fundament of the folds, and thus we have a number of new folds produced. Studies of cyst formation, normal and abnormal, should have a practical value in determining the conditions governing retention of glochidia.

Seasons of infection.—The time of infection must of course be limited to the breeding season of the mussels, but as the period of breeding covers months in both the long and the short period types, the more exact fixing of the time of infection may be important. I have already discussed the question in connection with *Q. heros*, as to

whether infection takes place in the autumn or spring. Lillie (1895) intimates that there is some development of the larvæ during the winter in the case of the long-period breeder *Anodonta cataracta.*

Lefevre and Curtis (1912) assume that development for anodontas is complete in the autumn. Harms (1909) suggests the probability of two broods in the short-period breeder, *M. margaritifera,* during July and August. Conner (1909, p. 112) gives the breeding period for this species as June and August. I have seen indications of two broods in the breeding of *Q. ebena,* and Lefevre and Curtis (1912, p. 114) mention similar observations. The settlement of this question would require the keeping of females under observation during the breeding period, but there is the difficulty that no one, so far as I know, has yet succeeded in getting these mussels to breed in captivity.

I have reported the absence of infections by *Q. pustulosa* after September 1. It is probable that September marks the limit of infections by short-period breeders. The finding of infections by long-period breeders early in the autumn and spring upon the sturgeon, *Scaphorhynchus platorhynchus,* and the wintering of *Q. heros* upon its host show that infections are not confined to late spring. It is to be expected that the period of infection would be adapted in large measure to the habits and seasonal migrations of fishes.

In general we may say that for most mussels in this climate the season of infection comes in the warmer months. In southern waters as much restriction would not be expected.

Metamorphosis during the parasitic stage.—The development of the young mussels in the post-embryonic or parasitic period has been systematically worked out in a number of forms (Brown, 1878a, 1878b, 1884, 1889; Schierholz, 1888; Harms, 1907a, 1907b, 1907c, 1908, 1909; Lefevre and Curtis, 1912). I wish here to call attention to some apparently decided differences in extent of development observed in natural infections. Differences in the amount of development of the larvæ at the end of the period of parasitism are very strikingly shown in a comparison of such species as *Lampsilis ligamentina* and *Lampsilis lævissima* (Coker and Surber, 1911). In the case of the former the juvenile mussel leaves its host with no shell beyond that of the glochidium (Lefevre and Curtis, 1912); in the latter there is a relatively enormous growth. This extra-glochidial growth I have observed in the following: *Lampsilis lævissima, L. alata, L. gracilis, Plagiola donaciformis, P. elegans* (Howard, 1912), and *Quadrula pustulosa.* The growth in the case of the large glochidia of *L. alata* (pl. IV, fig. 28) and *Q. pustulosa* (pl. III, fig. 19) is only sufficient to give the form of the shell of the adult mussel to the juvenile. In the others, which have very small glochidia, the great growth during the parasitic period would seem to be a compensatory

provision giving them the size of other juveniles when taking up the post-parasitic life. It would not be surprising if in the case of the latter the metamorphosis were carried further than in those forms which have no growth beyond the glochidial shell.

Duration of the parasitic period.—Periods of parasitism have been reported (Lefevre and Curtis, 1912, p. 168) as short as 12 days, and I have observed a period as long as six months in the case of *Q. heros* carried through the winter. These cases were observed in artificial infections. In natural infections I have seen evidence of a long period in mussels carried by the sturgeon, *Scaphorhynchus platorhynchus;* matured larvæ were seen in late season catches, while none were seen in those taken through April and most of May or in October. Lefevre and Curtis have called attention to the lack of correspondence between their results and those of other observers (Harms, 1907, 1909; Schierholz, 1888) as to the effect of temperature on the length of parasitism. Considering the great variation in the period of metamorphosis for different species, I think it is obvious that the influence of temperature could be determined accurately only in a single species or in species having the same period. Individual variation in the length of period for mussels which were implanted at the same time on the same fish Lefevre and Curtis explain as due to differences in nutrition of the larvæ.

Larval thread.—The presence of a thread gland and larval thread in the mature glochidium I have reported and described under *Quadrula heros* and *Quadrula plicata*. Lefevre and Curtis (1912, p. 151, 152), in a thorough discussion of this interesting organ, in which they state that they have found it only among the Anodontas and Unios, agree with Lillie (1895) that it is an excretory organ and the thread is an excretion primarily. They do not agree with Schierholz (1888) in considering the thread an efficient organ for aiding in attachment to fishes. In this connection it is interesting to note that in this form, which is the only one of its kind known to take the habit of external or fin infection, we have an organ that is characteristic of fin-infecting groups, *Anodontas* and the European *Unios*. Since making this observation on *Q. heros* I have noted the thread gland in *Unio gibbosus* and also observed this glochidium in natural infection upon the fins.

From these observations it looks as if this habit might have some bearing on the function of the thread gland. Here we have among the hookless glochidia a form showing the thread gland and thread more highly developed apparently than in the Anodontas. The inference is natural that the thread has some function other than excretion alone. If a fundamental embryonic (Lillie, 1895) organ present at some time in the development of all glochidia, its persistence to the mature state in some cases and not in others would

seem to indicate that its function later is not of a fundamental nature like excretion or it would persist in all. Lefevre and Curtis advance the argument that the threads are dissolved in a day or two and so are not effective during the greater part of the period in which the glochidia may be on the bottom. This would make no difference if infections take place at the time the glochidia leave the mussel, the evidence for which I have discussed above. (See conditions of infection in nature, p. 39.)

Absence of parasitism.—The interesting discovery of metamorphosis without parasitism as reported by Lefevre and Curtis (1912) for *Strophitus edentulus* (Say) suggests the possibility of some similar explanation for the absence of evidence of infection by some common species. This is especially to be looked for in species which have conglutinates similar in character to those of *S. edentulus*. I have in mind those of *Obliquaria reflexa* (Rafinesque). The fact that infections of this species have not been found lends support to the supposition that there is possibly something unusual in their life history.

Another species of mussel for which no natural infections have been reported is *Anodonta imbecillis*. While making measurements of the glochidia from a number of gravid individuals of this species collected during the month of November, I noticed that in many cases what I had supposed at first glance were mature glochidia were in fact juvenile mussels with organs developed to the stage usually seen in juveniles at the time they leave their host. These young mussels lie crowded in the marsupial gills of the parent without any conglutinate structure whatever. The outer gills, as in other anodontas, are marsupial, and these become well distended throughout their whole length when gravid.

In regard to the breeding of this species, Ortmann (1912) says it is gravid from September to May. My observations, which are rather limited, I give below:

Fairport, Iowa, July 16, 1910, 1 with glochidia.
Fairport, Iowa, May 13, 1912, 1 with glochidia.
Fairport, Iowa, May 27, 1912, 1 with early embryos.
Moline, Ill., September 24, 1912, 1 not gravid.
Moline, Ill., November 7, 1913, 2 with early embryos; 1 with both late embryos and glochidia, and 6 with juveniles.

In addition to these I have found numbers of free juveniles ranging from 5 to 30 millimeters not sexually mature. These stages are remarkable for the thinness of their shells and the flatness of the mussel as a whole. The term "floater" of the mussel fishermen for this type of mussel is well applied in its use for this species.

The presence of juveniles during November in the gills of a majority of the specimens examined seems to indicate that metamorphosis is

probably completed in the fall. The time of discharge of the young mussels is yet to be determined, but the appearance of glochidia again in early spring would seem to indicate that the juveniles escape in the fall or early winter.

Among the six lots of marsupial juveniles that I collected, the degree of development varied slightly as to amount of shell growth, otherwise there seemed to be little difference. This growth consists of a narrow rim only around the edge of the glochidial shell. The hooks of the glochidium are still much in evidence but are much weaker than in parasitic forms. A noticeable feature is the large proportion of gaping shells as compared with a similar lot of glochidia. It would seem that with the loss of the powerful single adductor muscle the action of closing is less vigorous. Between the gaping valves can be seen the ciliated foot, on each side the gill papillæ, two adductor muscles, mantle, etc., indicating a development equal to that of other young Naiades at the end of parasitism.

I have tested the reaction of the glochidia in the presence of fish and obtained strong evidence that they do not respond as other known parasitic forms. Mature glochidia taken in March were employed. In an exposure to fish for an hour they failed to give the usual infection. A few glochidia lodged in the mouths of the fish, but no encystment could be detected. The fish showed no response. Following this test the fish were exposed for 10 minutes to the glochidia of *Symphynota complanata* (Barnes.) These rapidly became attached and the fish showed considerable uneasiness, in marked contrast to their indifference in the presence of the other glochidia.[a]

From these observations I think I am warranted in concluding that this mussel passes through its metamorphosis without parasitism. The absence of a conglutinate (Lefevre and Curtis, 1912) or placenta (Sterki, 1898) is of interest, as we have here a case of nonparasitic development independent of this type of structure found in Strophitus.

It is a question whether the development, following the escape of the glochidium from the egg, is aided by absorption of food or not. One would expect the former, as it is evident that this species has descended from parasitic ancestors which received extraneous nutrition during the parasitic period.

The discovery of the absence of parasitism in this species already possessing the distinction of being hermaphroditic certainly adds to its reputation as an eccentric among its relatives in the Unionidæ.

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[a] Observations made since the above was written indicate that juveniles may be found in the marsupium at almost any time during the year. I have also been able to secure infections and encystment on fishes with *Anodonta imbecillis* as well as *Strophitus edentulus*. In the latter complete metamorphosis was observed. Thus for *edentulus* we have indicated facultative parasitism, while in the other we have a persistence of the parasitic reaction at least when artificially brought in contact with a host. Metamorphosis on fishes was not secured in *A. imbecillis*. Abundant additional evidence is at hand that development in this (*imbecillis*) species normally proceeds without parasitism.

JUVENILE STAGE.

The period in the life of the mussel following the parasitic stage has been given comparatively little attention by investigators. It is commonly stated that the mussel upon leaving the host assumes the adult form and manner of life. The investigations made upon this stage, however, indicate that the differences are probably of practical importance; that the adult form is not completely attained for some time (Schierholz, 1888), and that the manner of life may be quite different. According to Schierholz (1888, writing of the Unionidae):

> The following organs are acquired during this stage: The siphons, "Lippentaster," outer gills, and sexual glands. In *Anodonta* the outer gills are acquired the second summer, in *Unio* the third and fourth summer, while the sexual glands are developed in *Anodonta* the third summer and in *Unio* the fourth and fifth summer.

The acquirement of the sexual glands would mark the adult condition and the end of the juvenile period. The size upon first attaining the adult condition would, of course, vary considerably in individuals as well as in species. The smallest gravid mussels I have secured were 13 mm. in length. This was in the very small species *Plagiola donaciformis*, in which an example 50 mm. long would be exceptionally large.

The washboard (*Quadrula heros*), the largest of American mussels, has shell markings on the umbones that seem to be characteristic of the juvenile. These sculpturings mark the shell up to a size of 50 mm. to 60 mm., when they often cease abruptly. The size at maturity, according to the evidence I have, would be much greater, as the smallest breeding individual that I have collected was 91 mm. long. This showed a growth of three years beyond the juvenile shell and a total age estimated at 8 years.

In statistical estimates in ordinary sized species I have taken the arbitrary length of 20 mm. (Lefevre and Curtis, 1912) as a limit for the early juvenile stage. For large and small species it is evident this length would not be sufficiently accurate.

The sculpturings mentioned above for *Q. heros* are characteristic of the juveniles of most species, although they are absent in some. Commonly they are limited to the earlier portions of the shell.

The presence of a byssus in many species, as reported by Sterki (1891), Frierson (1903), White (1905), and Isely (1911) and the attachment of the young mussels to stones and gravel in shallow water I have been able to confirm in a number of cases, though, excepting *Q. plicata*, not among the *Quadrulas*. This habit of attachment in shallow water is found among the *Lampsilis* group, which in the adult stage are comparatively active mussels commonly in deep

water. This is a noteworthy contrast between young and adult as to habits and habitat.

In my investigations upon the juveniles I have not found the early stages as uncommon as the literature led me to expect (Lefevre and Curtis, 1912, p. 177). The clammers of the Mississippi River seem to be familiar with them, reporting that they often bring them up with the "spider web attached," referring to the byssus threads. Their small size makes them less conspicuous, and special apparatus is required for collecting them. In 1912 I found about 400 juveniles under 20 mm., exclusive of *Plagiola donaciformis*, and comprising 25 species.

Among the *Quadrulas* I have not found so great a difference, as a rule, in the habitat of juvenile and adult as Isely (1911) has reported for the Lampsilinæ (Ortmann). However, in species which show marked differences between juvenile and adult it is quite evident that in any scheme of propagation which would carry the young through this stage special consideration must be given this period of the life history.

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EXPLANATION OF FIGURES.

Photographs and drawings by the author, the drawings being made with the aid of a camera lucida.

Plate I.

Fig. 1. *Quadrula pustulosa* (Lea). Interior of right valve.
Fig. 2. Same individual. Exterior of left valve.
Fig. 3. Juvenile of same species.
Fig. 4. *Quadrula metanevra* Rafinesque. Interior of right valve.
Fig. 5. Same individual. Exterior of left valve.
Fig. 6. Juvenile of same species.
Fig. 7. *Quadrula ebena* (Lea). Interior of right valve.
Fig. 8. Same individual. Exterior of left valve.
Fig. 9. Juvenile of same species.
Fig. 10. *Quadrula trigona* (Lea). Interior of right valve.
Fig. 11. Same individual. Exterior of left valve.
Fig. 12. Juvenile of same species.

Plate II.

Fig. 13. Juvenile of *Quadrula heros* (Say).
Fig. 14. Adult of same species. Left valve.
Fig. 15. The same species. Interior of right valve.
Fig. 16. Juvenile of *Quadrula plicata* (Say).
Fig. 17. Adult of same species. Exterior of left valve.
Fig. 18. The same species. Interior of right valve.

Plate III.

Fig. 19. Glochidium of *Quadrula pustulosa* implanted upon the gill of *Ictalurus punctatus;* a natural infection taken August 26. Considerable development is evident from the growth of shell at the edge of the glochidial valves (*e. g. s.*) and two adductor muscles (*Ad. m.*) and foot (*fo.*) that are visible. The blood vessels (*B. V.*) of the fish's gills are seen to be inclosed by the valves of the glochidium. This is the same glochidium as that shown in figure 23.

Fig. 20. An abnormal cyst produced by the glochidium of *Quadrula pustulosa* upon the gill of *Ictalurus punctatus.*

Fig. 21. Glochidium of *Quadrula heros* showing the larval thread (*l. t.*) and larval thread gland (*lt. g.*) clearly differentiated by staining in borax carmine. The adductor muscle (*Ad. m.*) lies in the center.

Fig. 22. Glochidium of *Quadrula heros* with gaping valves seen from a side view. The larval thread (*l. t.*) is to be seen between the valves and its point of emergence ventral to the adductor muscle. Inner and outer sensory hair cells (*s. h. c.*) are visible on each valve.

Fig. 23. Filament of gill of *Ictalurus punctatus* naturally infected by the glochidium of *Quadrula pustulosa.* The cyst is set off on each side by incisions of the filament. This is somewhat characteristic of gill cysts in this species though not constant. The same glochidium is shown in figure 19.

Fig. 24. Encysted glochidium of *Quadrula ebena,* artificial infection upon *Micropterus salmoides.* The large size of the cyst is to be noted as characteristic of infections with this species of glochidium.

PLATE IV.

Fig. 25. A dorsal view of a juvenile of *Lampsilis alata*, 9 mm. long, showing the glochidial shell still visible. Magnification, 18 diameters.

Fig. 26a. A cluster of glochidia of *Quadrula heros* (Say), imbedded in the pectoral fin of a sheepshead, *Aplodinotus grunniens*. The fish was infected artificially October 7; these glochidia were removed by clipping off a small portion of the fin April 18. The soft parts are sufficiently distinct to permit the determination of the amount of metamorphosis which is nearly completed. Differences in appearance of the individuals are due chiefly to their varied orientation. The narrowest figure is an optical section taken in a transverse plane at right angles to the longitudinal axis. The preparation was stained by Mayer's hæmalum.

Fig. 26b. Gill filament of a sunfish, *Lepomis pallidus*, artificially infected by the glochidium of *Quadrula heros*. Age (Dec. 6), 69 days. The presence of two adductor muscles indicates that some metamorphosis has taken place. The cyst is seen to be thin as compared with some other species. Drawn in a living condition immediately after removal of the filament from the gill of the fish.

Fig. 27. Natural infection of the herring, *Pomolobus chrysochloris*, by the glochidia of *Unio crassidens*. This fish was captured May 16. The figure represents the tip of a filament shown chiefly in outline by dotted lines. The cyst includes a number of the finer subdivisions of the filament each with its afferrent blood vessel.

Fig. 28. A natural infection of the sheepshead, *Aplodinotus grunniens*, by *Lampsilis alata*. Considerable growth of shell is to be seen beyond the valves of the glochidium while still imbedded in the tissue of the host.

PLATE V.

Glochidia of species of *Quadrula*. All figures are magnified 275 diameters.

Fig. 29. *Quadrula lachrymosa* (Lea). A little immature; left valve, showing large mantle cells just beneath the very transparent shell and large adductor muscle.

Fig. 30. *Quadrula ebena* (Lea). Surface view of right valve, showing adductor muscle and pores of shell.

Fig. 31. *Quadrula metanevra* Rafinesque. Surface view of left valve.

Fig. 32. *Quadrula plicata* (Say). Right valve, showing thread gland passing around the adductor muscle and thread issuing posterior to the muscle.

Fig. 33. *Quadrula trigona* (Lea). A surface view of the right valve.

Fig. 34. *Quadrula solida* (Lea). A surface view of the left valve.

Fig. 35. *Quadrula heros* (Say). The left valve with the focus of the microscope slightly below the surface. The large light circle is the expanded portion of the thread gland. The shaded area represents an organ whose function has not been determined. A similar structure is visible in figs. 30 and 32; in the latter it appears to be continuous with the thread gland.

Fig. 36. *Quadrula pustulosa* (Lea). Left valve; surface view.

PLATE VI.

Fig. 37. *Quadrula pustulata* (Lea). Interior of the right valve.

Fig. 38. The same species. Left valve.

Fig. 39. Juvenile of the same species.

Fig. 40. *Quadrula granifera* (Lea). Interior of the right valve. The dark shade is due to the purple nacre of this shell.

Fig. 41. The same species. Left valve.

Fig. 42. Juvenile of the same species.

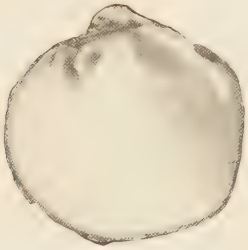
Fig. 43. *Quadrula lachrymosa* (Lea). Interior of the right valve.

Fig. 44. The same species. Left valve.

Fig. 45. Juvenile of the same species.

Fig. 46. *Quadrula solida* (Lea). Interior of the right valve.

Fig. 47. The same species. Left valve.



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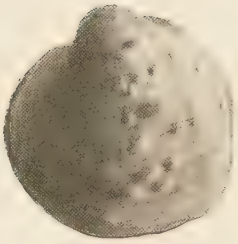

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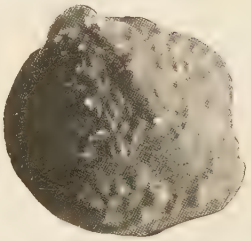

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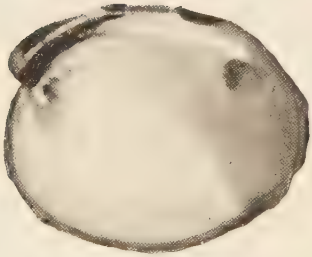

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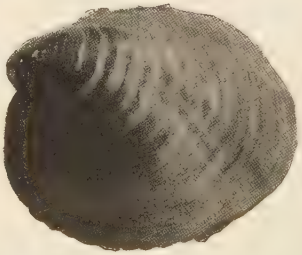

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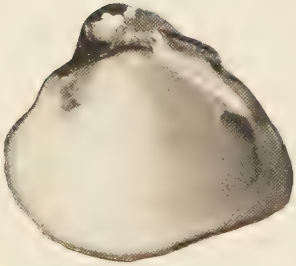

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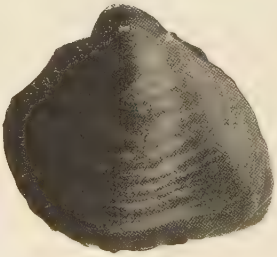

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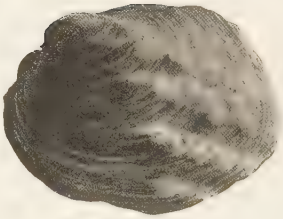

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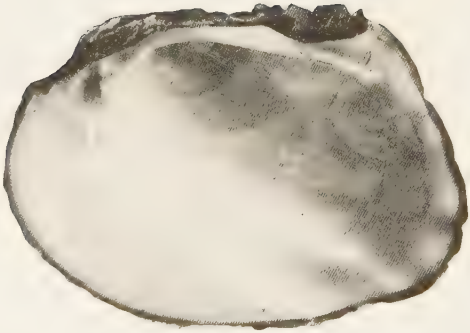

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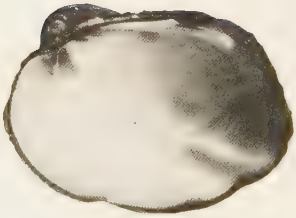

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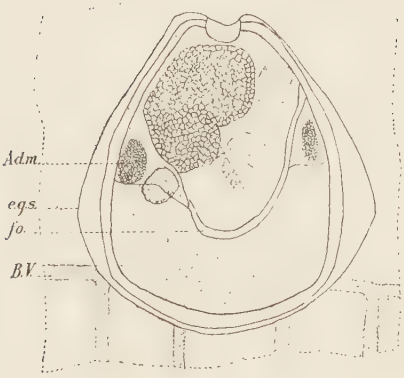

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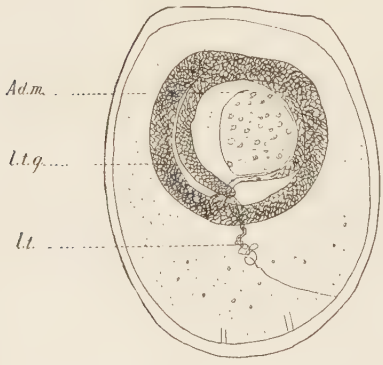

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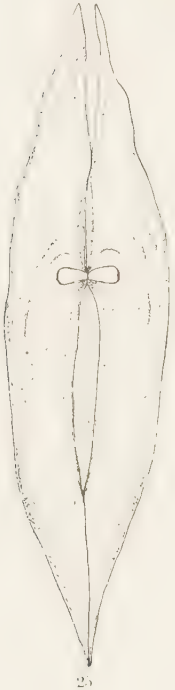

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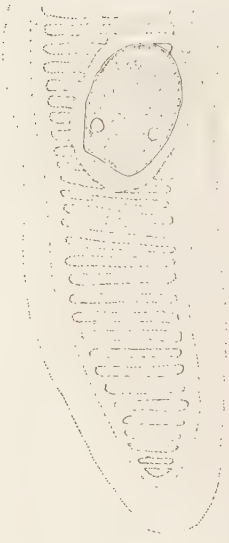

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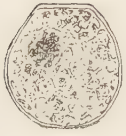
PLATE V.



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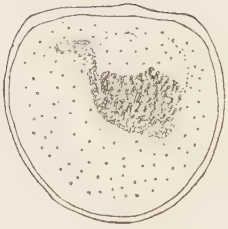

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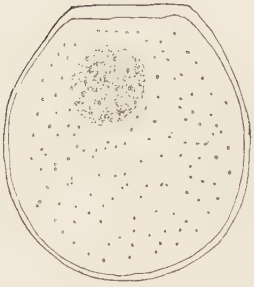

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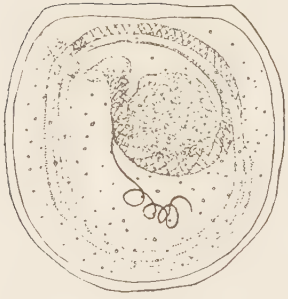

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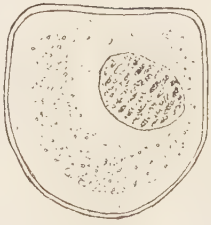

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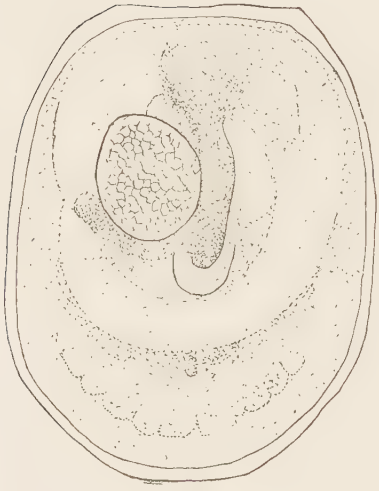

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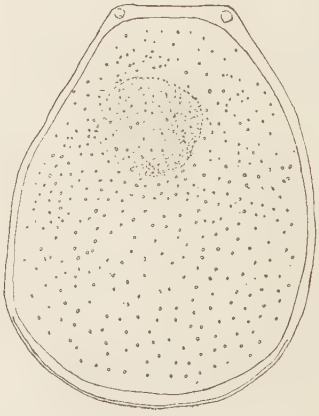

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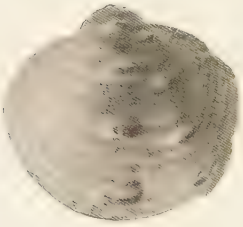

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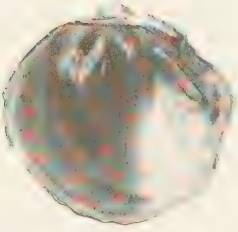

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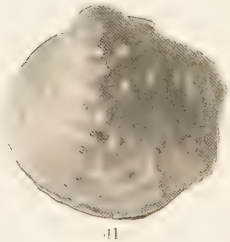

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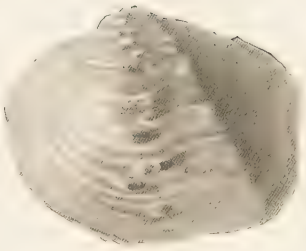

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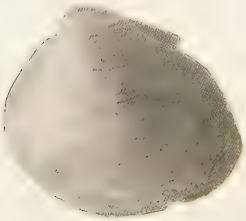

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THE MUSSEL FAUNA OF CENTRAL AND NORTHERN MINNESOTA

By Charles B. Wilson and Ernest Danglade

Appendix V to the Report of the U. S. Commissioner of Fisheries for 1913

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THE MUSSEL FAUNA OF CENTRAL AND NORTHERN MINNESOTA.

By Charles B. Wilson and Ernest Danglade.

INTRODUCTION.

As a part of the fresh-water mussel investigations conducted by the Bureau of Fisheries, the central and northern portions of Minnesota were examined during the summer of 1912 with regard to the kinds and numbers of mussels to be found in the lakes and rivers. The mussel fauna of the Mississippi River in Minnesota below St. Paul and of the Minnesota River have been thoroughly investigated by representatives of the various pearl-button companies, and the quality and amount of shells which they produce have become fairly well known. The central and northern portions of the State had never been examined except by mussel fishermen. The shells obtained by some of these fishermen, however, and shipped to the button factories were of such exceptional quality as to attract the attention not only of the manufacturers but also of the Government experts at the biological laboratory at Fairport, Iowa. Since some of these shells were obtained from lakes and others from rivers, it was determined to make a preliminary survey of both lakes and rivers through the central and northern portions of the State.

This survey had a threefold object: First, to determine the geographic distribution of the various mussels in those portions of the State. Incidentally, of course, this would answer the question whether the exceptionally fine shells were locally or generally distributed, and where they were to be found.

Second, to make as careful a survey as possible of the various conditions, conducive or adverse to mussel development, in the different localities visited. This would not only throw some light on the presence of exceptional mussels in certain localities, but would also serve as a basis for the final object of the survey.

Third, to ascertain whether it would be profitable to introduce artificial propagation in any of the lakes or rivers, and if so, what species would be best adapted to the locality.

The investigating party consisted of the two authors, and in consequence of the large territory to be covered and the isolation of many of the localities visited it was necessary to travel entirely by rail-

road, stopping at convenient centers and driving to the lake or river. During this trip 45 lakes and 15 rivers were examined, with the results as herein given.

Samples of the shells obtained by the authors at the different localities herein mentioned have been identified by Mr. H. Walton Clark, of the biological station at Fairport, Iowa. Similar samples have been tested as to their mercantile value by Mr. John Southall, of the same station.

In order to understand the geographic distribution of the mussels, it is necessary to review so much of the glacial geology as will explain the present location of the lakes and rivers as well as their former relations.

GLACIAL ORIGIN OF LAKES AND RIVERS.

Minnesota was formerly covered by a great glacier or ice sheet, which came down from the northeast and flowed across the State into Iowa. When the glacier melted, the gravel, sand, and clay which it carried was spread out over the surface of the underlying rocks and has remained there ever since. The only exception is a narrow strip bordering the Mississippi River from Lake Pepin southward, and thus outside of the present survey. North of Lake Superior this drift, as it is called, is thin in places, but elsewhere it averages from 100 to 150 feet in thickness and effectually conceals the bedrock.

Both glacier and drift have made the contour of the State more level and uniform than it was before. The glacier accomplished this by grinding off the ridges and elevations, while the drift assisted by filling in such hollows as were left by the glacier. In some places the material of the drift has been subsequently worked over and arranged in layers by the streams and rivers that flowed from beneath the glacier, but in most places it is still unstratified. During the melting of this great glacier there were successive periods of advancing, halting, and retreating, and at such times the drift accumulated in long hills or ridges called moraines, parallel with the edge of the glacier. Twelve of these moraines may be traced across the State in various directions, and while they are only from 25 to 75 feet in height, they are still sufficient to determine the general drainage of the State. They have the further effect of rendering any free drainage impossible, and thus they give rise to the remarkable number of lakes that are found in Douglas, Ottertail, Itasca, and other counties. Furthermore, the streams and rivers are very winding, and have a uniform current, and there are plenty of sand and gravel beds in the bottom of the lakes and rivers, and not very much mud. All these conditions are favorable for mussel growth and propagation and profoundly influence the mussel fauna.

When the melting ice sheet had receded beyond the moraine or watershed which separated the basin of the Minnesota River from

that of the Red River of the North, a large lake, called Lake Agassiz, was formed along the edge of the ice. As the ice withdrew, this lake extended northward along the Red River Valley as far as what is now Lake Winnipeg. Lake Agassiz was 700 miles long and covered 110,000 square miles, and its duration is estimated to have been about a thousand years. Its outlet, known as the glacial river Warren, was along the valley now occupied by Lakes Traverse and Big Stone and the Minnesota River, into the Mississippi. At that period, therefore, the Mississippi River may be said to have had its origin in Lake Agassiz. And during the thousand years of its existence, this lake had abundant opportunity to become populated with fresh-water mussels ascending from the Mississippi. The lake disappeared, however, and the valley of the Minnesota River separated from that of the Red River. But the mussel faunas of the two rivers were derived from identically the same source, and the only differences would be the few minor changes that have crept in since then.

Many other glacial lakes were formed during the melting of the ice sheet, only to be subsequently obliterated. But while they existed they served as temporary channels for the migration of fish and mussels from the south. Two of these are of especial interest, in view of the results of our present investigation. Lake Upham once covered the region south of the Mesabi Iron Range, and drained southeast along the valley now occupied by the St. Louis and Cloquet Rivers. This lake was very shallow and temporary and, as far as can be determined, was not connected with the Mississippi River in any way. This fact accounts for the paucity of mussels in that portion of the State, as well as in all the Lake Superior drainage.

Lake Nicollet was formed around the headwaters of the Mississippi River and covered an area of 1,500 square miles. It drained southwest into the valley now occupied by the Crow Wing River and thence into the Mississippi. The Crow Wing River thus becomes the modern representative of the old headwaters of the Mississippi, and is older than that portion of the latter river which now extends from the mouth of the Crow Wing up to Lake Itasca. These facts explain the richness of the mussel fauna in the Crow Wing and its tributaries. At two places in the area covered by the present survey the bed rocks appear above the drift with sufficient prominence to materially affect the mussel distribution. At Carlton the St. Louis River plunges over a rocky ledge and through a gorge, which prevents the passage of either fish or mussels. Consequently that portion of the Lake Superior drainage which is tributary to the St. Louis River above Carlton is devoid of mussels.

The Falls of St. Anthony at Minneapolis have formed a similar barrier in the Mississippi River, but with this difference: Some fish have evidently been able to ascend these falls while others could not accomplish it. Accordingly, we find in the Mississippi above the falls, and in its tributaries an abundance of mussels belonging to the *Lampsilis* or mucket group, plenty of *Anodonta*, *Symphynota*, *Strophitus*, and the like, but not a solitary specimen was seen of the great *Quadrula* or pig-toe group. The falls have manifestly furnished in some way an effective barrier to the distribution of these mussels. On the other hand, the Minnesota River enters the Mississippi some distance below the falls, and it contains as many pig-toes as muckets.

The pig-toes also ascended the glacial river Warren into Lake Agassiz, and we find them to-day in the Red River of the North. They also ascended the St. Croix River, and in the St. Croix drainage they are even more numerous in species than the muckets.

For convenience we may divide the lakes and rivers which were examined into five groups, and designate them, respectively, the St. Croix group, the Minnesota River group, the Red River group, the Crow Wing group, the Mississippi River group, and the isolated lakes.

MUSSELS OF THE ST. CROIX GROUP.

The lakes and rivers in this eastern central portion of Minnesota have been populated with mussels by way of the St. Croix River. This connection was established after the melting of the glacier and has not been materially changed since that period.

Joining the Mississippi some distance below St. Paul, and having no falls or other natural obstruction in its own course, the St. Croix River has afforded a constant and easy passage for all the Mississippi species of fish and mussels. Hence we find a goodly variety of both in the lakes and rivers belonging to the St. Croix drainage. The following table gives the geographic distribution of the various mussels found here during the present survey:

DISTRIBUTION OF MUSSELS IN ST. CROIX DRAINAGE.

Species.	Pokegama Lake.	Snake River.	Cross Lake.	Rush Lake.	Bald Eagle Lake.	White Bear Lake.	Forest Lake.
Lampsilis luteola (fat mucket)	×	×	×				×
Lampsilis ventricosa (pocketbook)	×	×	×				
Lampsilis recta (black sand-shell)		×	×				
Lampsilis alata (pink heel-splitter)		×	×				
Symphynota complanata (white heel-splitter)			×				
Strophitus edentulus (squaw-foot)	×						
Anodonta corpulenta (floater)	×		×	×	×	×	×
Quadrula undulata (blue-point)	×	×					
Quadrula plicata (three-ridge)		×	×				
Quadrula undata (pig-toe)	×		×				
Quadrula lachrymosa (maple-leaf, stranger)	×	×	×				
Quadrula pustulosa (warty-back)	×	×					

No comment upon the fauna of the last four lakes is needed save the single statement that the muckets in Forest Lake are all dwarfed and thin-shelled. The other two lakes and Snake River are parts of the same system, for the river flows through the entire length of Pokegama Lake and across Cross Lake nearly at its center. Both of the lakes and the river are shallow, and consequently the mussels are gathered with a rake or by wading. No crowfoot dredges were seen.

QUALITY OF SHELLS.

The principal mussel here is the fat mucket, which is not dwarfed, as is usual in a lake, but retains its full size. Furthermore, the shell is exceptionally thick and heavy, and maintains this thickness to the extreme tips, making every portion of it available for buttons. The shells have a fine luster, show no discoloration, and will cut from 700 to 720 gross of blanks (20-line) to the ton. In Pokegama Lake these muckets form 75 to 85 per cent of the entire catch; in the Snake River between the two lakes, 60 per cent, and in Cross Lake from 40 to 50 per cent.

Of the other shells, the maple-leaves and blue-points are also exceptionally thick, of large size, unspotted, and in every way first-grade button shells. The three-ridges, on the contrary, are badly spotted, have a poor luster and are only second or third quality. The culls are nearly all heel-splitters and *Anodontas*. In Cross Lake the bottom is sandy next to the shore, and then becomes covered with mud, while in Pokegama Lake it is hard sand throughout. Hence there are more three-ridges, black sand-shells, blue-points, and floaters in Cross Lake, and the shells are not quite as thick as those in Pokegama Lake.

At the time these lakes were examined (July) there were fully two carloads of shells scattered along the shores of Cross Lake on the west side, and as many more at the upper end of Pokegama Lake, gathered within a space of 400 or 500 feet. The fishermen said they had been offered $23.50 per ton for these Pokegama shells.

PEARLS.

The best pearl found in this vicinity was obtained from a fat mucket in Cross Lake several years ago, and was held for some time at $4,000. The price then gradually dropped to $3,000, and it was finally sold for $2,300. Of those found in 1912 one brought $1,800, another $1,200, a third $900, two were sold for $500 each, and six or eight reached $100 or over. In consequence of these exceptional finds everyone in the neighborhood caught the pearl fever, and they were all—men, women, and children—fishing for pearls at the time of our visit, the mucket being the favorite shell for them. But they

showed far more wisdom than is common under such circumstances, for even the children had sense enough to save the valuable shells and turn them over to a local blank factory situated on the shore of Cross Lake in Pine City. At that time this factory was running entirely on such small job lots, which could be obtained at a considerable reduction in price.

PROPAGATION.

Some of the mussel fishermen claimed that this locality was practically worked out, and in consequence they had left and gone to Rice Lake. But all of those who remained told us that they had no difficulty in gathering 500 or 600 pounds a day. The supply, however, is not inexhaustible, and unless measures are taken to replenish the more valuable species they will soon be gone.

Everything combines to make this an ideal location for such artificial propagation. Pine City, the county seat of Pine County, is conveniently reached by the Northern Pacific Railroad, 60 miles from St. Paul. It is located on the shores of Cross Lake and along the banks of Snake River, and the waterway is unobstructed up the river into Pokegama Lake. Hence propagation at a single point would supply both of the lakes and the river. And there is an abundance of the right kind of fish to serve as hosts for the glochidia.

RECOMMENDATIONS.

1. The muckets and the maple-leaves that are found here are exceptionally fine shells, and in some way the local conditions are peculiarly suited to their development. They should be locally propagated, therefore, in sufficient numbers to keep up the supply. In all probability they will yield better returns than any other species that could be introduced.

2. A careful study of these mussels and of the local conditions should be undertaken in order to determine, if possible, what it is in the way of lime, food, or other things that renders these shells so exceptionally fine.

3. With a good local supply of these remarkable shells and a working knowledge of the conditions under which they flourish, it would be a simple matter to introduce them into other localities having a similar happy combination of river and lake. Among such possible localities may be mentioned Rice and Koronis Lakes near Paynesville in Stearns County, Clearwater Lake near Annandale in Wright County, Lost and West Lost Lakes near Fergus Falls, and Pine and Little Pine Lakes near Perham in Ottertail County.

4. A small local factory may often render efficient service by saving the odd lots of shells that are just as good in quality as any of

the others and perhaps even better, but are not sufficient in quantity to warrant shipping them for any distance. Such factories deserve the encouragement of both fishermen and manufacturers.

MUSSELS OF THE MINNESOTA RIVER GROUP.

As has been already stated, the Minnesota River and its tributaries have been pretty thoroughly worked up by representatives of the button factories. Like the St. Croix, this river empties into the Mississippi below the Falls of St. Anthony, and so affords a free passage for all kinds of fish and mussels. Furthermore, it formed a part of the glacial River Warren, which was the outlet of Lake Agassiz, and thus there has been no break in its connection with the Mississippi.

The present investigation did not include the river itself, but only some of the lakes in Douglas County that eventually drain into it by way of the Chippewa River.

Within a radius of 6 miles from Alexandria, the county seat of Douglas County, there are 20 small lakes, several of which have become quite noted summer resorts.

Lakes Agnes, Henry, and Winona are close to the railroad station, small, shallow, and filled with water plants. The only mussels found in them were dwarfed and thin-shelled muckets (*L. luteola*), whose epidermis was highly polished and somewhat marly and whose nacre was a beautiful smoky brown.

Four miles north of the city there is a group of three larger and much deeper lakes, called, respectively, Darling, Carlos, and L'Homme Dieu. These lakes are comparatively free from water weeds, have sand and gravel bottoms, are very deep, and contain plenty of fish, but the only mussels that could be found in them were *Anodontoides freussacianus modestus* and *Anodonta pepiniana*.

A similar fauna was reported for the other 14 lakes, so that it does not appear as if any of the lakes in Douglas County contained commercial shells. Nor do any of them present conditions that would recommend the introduction of merchantable species by means of artificial propagation.

Some of the isolated lakes in this drainage, however, present entirely different conditions.

MUSSELS OF THE RED RIVER GROUP.

The lakes and rivers belonging to this group were populated with mussels from the Mississippi River by way of the glacial river Warren and Lake Agassiz. Since the disappearance of this glacial river and lake the Minnesota River drainage and the Red River drainage have been separated, and each has acquired peculiarities of its own. The Red River turns northward along the western border of the

State and carries its mussel fauna across the line into Canada. It therefore becomes of great interest to the conchologist, as well as the mussel fisherman, since in it the mussels of the Mississippi Valley reach the point farthest north in their migrations. In consequence of the long continued glacial connection with the Mississippi, we are not surprised to find the rich mussel fauna indicated in the following table:

DISTRIBUTION OF MUSSELS IN RED RIVER GROUP.

Species.	Little Pine Lake outlet.	Red River at Perham.	Otter-tail Lake outlet.	West Lost Lake outlet.	Red River below Fergus Falls.
Anodonta pepiniana (paper-shell, floater)	×	×	×	×	.....
Anodontoides ferussacianus subcylindraceus	.....	.....	×	.....	.....
Strophitus edentulus (squaw-foot)	.....	×	×	×	.....
Symphynota costata (fluted-shell)	×	×	×	.....	.....
Symphynota complanata katharinæ	×	×	.....	.....	.....
Lampsilis luteola (fat mucket)	×	×	×	×	×
Lampsilis ventricosa (pocketbook)	×	×	×	.....	×
Lampsilis recta (black sand-shell)	×	×	×	×	×
Quadrula coccinea (round pig toe)	.....	.....	×	.....	.....
Quadrula rubiginosa (Wabash pig toe)	.....	.....	.....	.....	×

The only place in this entire drainage that has ever been worked is just north of Fergus Falls, where some of the country boys gathered and shipped a carload of shells to the button factories in Iowa in 1910. All of the lakes and the river are shallow and the shells must be gathered with rakes or forks, or picked up by hand; there is no chance for crowfoot dredges.

QUALITY OF SHELLS.

The mucket, the pocketbook, and the fluted shell are the principal commercial mussels in the Red River. The black sand-shell is abundant and the best shell of them all in quality, but as it always has a dark purple nacre it can be used only for novelties. In many of these northern sand-shells, the hinge line, instead of being straight (*recta*), is strongly curved. But as it conforms in other particulars to a normal *recta*, it seems best to regard this merely as a local variation. The pocketbooks also are peculiar in being much flattened, somewhat elongated, and with short and stumpy teeth, very much like the variety designated by Lea as *Unio canadensis*. Many of the muckets have shells as thick and heavy as those of the St. Croix drainage, but there are others whose shells are thin and sometimes dwarfed like lake specimens.

The shells of nearly all the mussels which have a white nacre are badly stained. These stains vary from a light-gray or drab to a dark rusty brown in color. Sometimes there is but a small discoloration

on each valve, at other times the whole interior of the shell is discolored. The stain usually affects only the interior layer or coat of nacre and when this is removed the rest of the shell is perfectly clean and uninjured. Such spotting of the shell, of course, injures their commercial value and reduces the material to the second or third grade. In other respects the shells have a fine luster and good texture, and would make excellent button material.

PEARLS.

A few pearls and about the usual number of slugs were obtained from the carload of shells sent from Fergus Falls. At Little Pine Lake we also received reliable information that pearlers had worked the Red River above Mud Lake two years before, and that they obtained an abundance of mussels, with a fair amount of pearls. Further than this there has been no search for them in the Red River. If the discoloration noted above is due to some sort of parasite, it would very likely affect the pearls and slugs as well as the shells, but no data could be obtained. There is no reason other than this why the Red River should not be as prolific of pearls as the Mississippi.

PROPAGATION.

The conditions at Ottertail Lake are very favorable for the propagation of certain species of mussels. The lake is 10 miles long by 4 miles wide, and is remarkably clean and free from weeds. It is surrounded also with fine sand and gravel beaches and contains many large sand bars. The Red River enters at the northeastern corner and flows the entire length of the lake. Similar conditions exist at Lost, West Lost, Pine, and Little Pine Lakes, but the lakes themselves are much smaller. At little Pine Lake the bottom was nearly covered with *Chara* and algæ, but wherever there was a bare spot the mussels were present in large numbers. As these lakes are full of just the kind of fish to serve as hosts the conditions are ideal for mussel propagation. On the river itself the conditions are less favorable. There are several dams in Fergus Falls, and a large power dam, 36 feet in height, 4 miles below the city. None of these dams are provided with suitable fishways, so that they form an effective barrier to the ascent of all fish.

RECOMMENDATIONS.

1. Evidently the first thing to be done is to determine the cause of the stains which are so abundant. A satisfactory solution of this question would be of immense practical value, not merely here in the Red River drainage but wherever mussels are found. Different

regions show different degrees of discoloration but stain is present in some degree practically everywhere. How to check it, control it, and eventually eliminate it become exceedingly important questions. This Red River offers ideal opportunities for solving these questions.

2. Practical and efficient fishways should be provided for every dam across a river of the size and importance of the Red River. The blocking of the passage of the fish not only hurts the fishing in the waters above the dam but seriously affects every industry that is at all dependent upon fish. A dam or a natural fall, impassable for fish, may mean the entire absence of mussels in the river above.

3. Until there has been a solution of the cause of the numerous stains on the Red River shells and suitable means have been provided for the passage of the fish around the dams, there is little to be gained either by propagating the mussels already in evidence or by introducing new species.

4. Since the staining is the only character in which these shells are not first quality, since quite a percentage of the shells are free from stains, and since a goodly proportion (unstained part) of most of the stained shells can be utilized for buttons, it follows that a local blank factory, using the shells where they were found would obtain an abundance of material. The loss occasioned by the stained portions of the shell would be more than offset by the saving in freight.

MUSSELS OF THE CROW WING GROUP.

The lakes connected with this group were once part of the great glacial lake Nicollet, which covered 1,500 square miles and drained southwest through the Crow Wing River into the Mississippi. This drainage, therefore, represents the original headwaters of the Mississippi River and was populated with mussels from that source. The center of the Crow Wing drainage is in Wadena County, from whence it extends north through the Fishhook River into Hubbard County and nearly up to the present headwaters of the Mississippi; west through Straight and Shell Rivers into Becker County; west also through Red Eye, Leaf, and Wing Rivers into Ottertail County, and south through Wing and Turtle Rivers into Todd County.

There are very few lakes in this drainage and they are close to the headwaters of the various tributary rivers. Both the lakes and the rivers are shallow, with sand or gravel bottoms; the mussels thus far secured have been obtained with forks and rakes; there was no opportunity to use a crowfoot dredge. The following table gives the distribution of the mussels in this group:

DISTRIBUTION OF MUSSELS IN CROW WING GROUP.

Species.	Stations.			
	Shell River, Menahga.	Leaf River, Wadena.	Fish-Hook River, Park Rapids.	Crow Wing River, Motley.
Lampsilis ligamentina (mucket)	×			×
Lampsilis luteola (fat mucket)	×	×	×	×
Lampsilis ventricosa (pocketbook)	×	×	×	×
Lampsilis recta (black sand-shell)	×			×
Anodonta pepiniana		×		
Anodonta grandis (floater)	×	×	×	
Anodontoides ferussacianus subcylindraceus		×	×	×
Strophitus edentulus (squaw-foot)		×	×	
Strophitus edentulus pavonius (squaw-foot)		×	×	

As can be seen from this table, the mussels are quite evenly as well as universally distributed, and it may be said that they were also fairly abundant at every place examined. Hitherto the mussel fishermen have worked at only one locality in this drainage, the Shell River at Menahga, but the shells obtained here were so exceptional in size and quality that they brought a high price, and many of them were exported to England and Germany.

QUALITY OF SHELLS.

The principal mussel of this drainage is the pocketbook, which attains a large size and has an exceptionally thick shell. It also shows a good luster, has a fine texture, and is free from stains. Consequently it ranks as a first-grade shell and will cut 100 gross of 20-line and 1,000 gross of 16-line buttons to the ton.

The bottom of the river where these shells are obtained is covered with algæ and water weeds to the depth of 12 to 18 inches, and the thicker the vegetation the more plentiful the mussels beneath it. Two men were actively working the Shell River at Twin Lakes near Menahga at the time of our visit, and we watched them rake off the algæ and weeds and then dig into the underlying gravel and sand for the mussels. The latter are often buried to the depth of a foot or more. This is, at the least, a novel condition and one which, so far as is known, has not been reported from any other locality.

The Anodontas were also very thick shelled, so thick as to be easily mistaken for fat muckets, and to cut a poor quality of buttons, Quite a large percentage of the black sand-shells had white nacre, and of course these made first-quality button shells.

PEARLS.

The slugs and small pearls from these shells run about 1½ ounces to the ton of shells, which equals that of the Illinois River, is twice the average for the Cumberland River, and three times that for the Ohio.

An ounce of these pearls and slugs was purchased and they have been carefully examined and compared with those from other localities. In luster and general character they are considerably better than those from the Illinois and Ohio Rivers, but are not equal to the Wabash River output.

One of the musselmen at Menahga showed us a large rosebud cluster of yellowish tint and the size of a small hickory nut, which was attached to the valve of a mucket near the posterior end. They also had several fine pearls, rather more than would be expected from the quantity of shells they had obtained.

While conditions in the Crow Wing and its tributaries are exceptionally fine, as is evidenced by the superior quality of the shells, and while there is an abundance of the right kinds of fish to serve as hosts, these advantages are more than offset by the very poor facilities for transportation.

The rivers run through those portions of Wadena County which are the farthest removed from railroads, and not until we reach Motley in Morrison County do we find good railroad facilities. Even at Menahga the shells must be carted 5 miles over a very sandy road in order to reach a shipping point. The Shell River, however, will furnish gravid pocketbooks of exceptional size and quality to stock other rivers that happen to be more conveniently located.

RECOMMENDATIONS.

1. One of the musselmen at Menahga suggested a way to overcome the lack of transportation facilities. A "wannigan" as he called it—that is, a sort of house boat—could be built and equipped with machinery for sawing blanks at an expense not greatly, if at all, exceeding what it now costs ($300) to transport a single carload of shells from Menahga to the button factories. With this equipment it would be an easy thing to float down the Shell River into the Crow Wing, and down the latter into the Mississippi, using up the shells where they were found. The Crow Wing and its tributaries would supply enough material to keep such an outfit busy for several years. There would be no freight or transportation charges on the shells. Spotted shells, those with thin tips, and the white-nacred sand shells could be utilized along with the others, and when the work was finished the boat and its outfit would bring a very respectable portion of the original cost.

2. While the shipping facilities do not warrant artificial propagation in this drainage, such exceptional shells should not be allowed entirely to disappear before an earnest effort is made to introduce them in other localities. Here is a peculiarly fine parent stock which richly deserves protection and cultivation as a source from whence to derive propagation material.

MUSSELS OF THE MISSISSIPPI GROUP.

As would be expected, this is much the largest of the groups here considered, and includes all of the Mississippi River above the mouth of the Crow Wing River, together with the lakes and tributaries connected with it. This portion of the Mississippi is entirely postglacial and has been formed since the disappearance of the glacial lake Nicollet.

It drains Crow Wing County, the northern portions of Aitkin, Cass, and Hubbard Counties, and the southern portions of Itasca, Beltrami, and Clearwater Counties. All of these regions, but especially Itasca County, contain a large number of lakes, some of which, like Leech, Winnibigoshish, and Cass Lakes, are among the largest in the State. This region, of course, has been in constant communication with the Mississippi since the very beginning and hence has been stocked with samples of all the mussels found in that river above the Falls of St. Anthony. The following table gives the geographic distribution of these mussels:

DISTRIBUTION OF MUSSELS IN THE MISSISSIPPI GROUP.

Species.	Mississippi River, Brainerd.	Prairie River, Grand Rapids.	Prairie Lake, Grand Rapids.	Mississippi River, Wolf Lake.	Mississippi River, below Bemidji.	Mississippi River, Bemidji Lake.	Mississippi River, above Bemidji.
Lampsilis ligamentina (mucket)				×	×	×	
Lampsilis luteola (fat mucket)	×	×	×	×	×		×
Lampsilis ventricosa (pocketbook)				×	×	×	×
Lampsilis recta (black sand shell)		×		×	×	×	×
Anodonta grandis (floater)		×	×	×		×	×
Anodonta corpulenta (floater)		×	×				
Anodontoides ferussacianus subcylindracus			×	×		×	×
Symphynota compressa						×	×
Strophitus edentulus (squaw-foot)						×	
Strophitus edentulus pavonius (squaw-foot)				×			×

The poverty of specimens at Brainerd is explained by the fact that we could only examine the river for a short distance above and below the city, and in this interval we did not find any mussel bed. Doubtless there are as many mussels in this portion of the Mississippi as elsewhere.

QUALITY OF SHELLS.

The *Lampsilis* or mucket group are the only mussels in this drainage that possess any commercial value. While the pocketbook does not attain the size or the quality of those found in the Shell River, and the fat mucket is not as thick at those found in Snake River and Pokegama Lake, yet on the whole the shells are of medium size and good quality. They are very plentiful in many places; at the outlet of Lake Bemidji 3 tons were obtained in one week from a space only a few rods in length. These mussels are like those in the Shell River, in that they are buried deep. The man who collected them told us that he dug down into the sandy bottom 2 and 3 feet for them and found them nearly as thick as they could lie.

The shells were remarkable for the small size of the cardinal teeth, indeed a few valves were found entirely destitute of teeth.

Another excellent locality is up the Mississippi above Lake Irving. The conditions here are excellent and several carloads of shells could easily be obtained. The Schoolcraft River comes into the Mississippi here from Lakes Marquette and Plantagenet and both the river and the lakes are reported to be full of good mussels.

The black sand-shells throughout this portion of the Mississippi have the hinge margin very strongly curved like those already described from the Red River and the Crow Wing drainage.

The fat muckets here are not thickened like the shells from Pokegama Lake, Pine County, and many of them are dwarfed after the manner of ordinary lake shells. In addition, those from Wolf Lake proved to be chalky and brittle when tested for button making, but those above Lake Bemidji were of medium size and furnished good button material.

The Anodontas form but a very small percentage of the mussel fauna, nearly all the shells seen being some form of *Lampsilis*. The mussels in this region would all be obtained with a fork or a rake; there is no locality where the water is deep enough to use a crowfoot dredge.

PEARLS.

Quite a number of pearls and slugs have been obtained by professional pearlers, especially in the region about Bemidji. One beautifully colored pearl as large as a hazelnut had been purchased by a firm of jewelers in Bemidji just before our arrival there and was valued at $200. It weighed 21 grains, but had a slight blemish on one side. Some pearling has also been done in the Mississippi below the power dam, which is situated 11 miles down the river from Lake Bemidji. One pearl found here in July, 1912, was valued at $300. There was also a display of pearls and slugs and manufactured

articles in the window of this jewelry store, all of which were stated to have been found in the vicinity. We saw several piles of shells that had been recently made by pearlers along the stretch of river above Bemidji, but did not find them anywhere else in this drainage. Evidently there has been very little search for pearls anywhere within this entire drainage.

PROPAGATION.

The conditions in most of the lakes and rivers of this group are excellent for propagation purposes. The water everywhere is clear and contains an abundance of lime; the bottom is almost universally composed of hard sand and gravel; there is nowhere any surfeit of algæ or aquatic vegetation, and there is apparently an abundance of food.

At Leech Lake, which, next to Red Lake, is the largest body of fresh water in the State, the outlet is muddy and full of weeds, and is reported to contain nothing but very thin-shelled floaters or paper shells. But the lake itself presents ideal conditions, and a small river which runs into it on the south shore out of Lake Linda is reported by a mussel fisherman to be full of thick shells for the mile of its course. The same fisherman said that Little Bay River, which enters the lake on the west shore, contains no commercial mussels from Leech Lake up to Laura Lake, but from there up to Little Bay Lake is full of them.

Lake Winnibigoshish was formerly a shallow mud lake, but its surface was raised 14 feet by a dam across the outlet. It would furnish a favorable locality for the introduction of the three-ridge, blue-point, washboard, and similar mud-loving species.

Cass Lake, Long Lake, and Wolf Lake are also very favorably situated, and all three, as well as the intervening portions of the Mississippi River which connects them, contain good bottom material. The conditions here are similar to those on the Snake River in the St. Croix drainage, and would be particularly well suited to the thick-shelled fat muckets.

The Mississippi flows through Lake Bemidji and Irving Lake to Beltrami County, and here again the conditions appear very propitious for the propagation of the fat muckets.

At Pokegama Lake in Itasca County there are long stretches of sandy beaches and numerous sand bars, which, combined with something of a current flowing through the lake, would favor the introduction of the yellow or slough sand-shells. This lake is 14 miles in length, but is quite narrow, and is made up of a succession of long arms and bays surrounded by fairly high land. A dam was placed across the outlet about 8 years ago, which raised the water in the lake 10 feet, and which effectually prevents any fish from entering the lake out of the Mississippi River.

At Prairie Lake, 6 miles north of Grand Rapids, the water is considerably discolored with iron brought down by the Prairie River from the Mesabi Iron Range. This iron does not appear to affect the mussel fauna at all, since they are neither stunted nor discolored. But thousands of logs are run down the Prairie River, and the bottom of both the river and much of the lake is covered so thickly with fragments of bark that no mussel can live in it.

It is hardly necessary to add that all these lakes, the Mississippi itself, and its tributaries are full of just the right kind of fish to serve as hosts. Furthermore, Walker, Cass Lake, Bemidji, and Grand Rapids are very conveniently situated for propagation work, and are in easy railroad communication with all other parts of the State.

RECOMMENDATIONS.

1. As noted under the Red River group, suitable passage should be provided for fish around the dams at the outlet of Lakes Pokegama and Winnibigoshish, and the large power dam 11 miles below Lake Bemidji. These last two are across the Mississippi, and surely that river ought never to be closed to the passage of fish, to say nothing about the mussels.

2. The farther the source of supply is removed from the button factory the greater is the cost of transporting the shells. Therefore, in a city like Bemidji, forming a convenient center, the establishment of a local factory for sawing blanks can not be too strongly recommended.

3. This is not the best locality for trying the experiment of introducing commercial species of mussels into some of the Minnesota lakes. But after such an experiment has been made a thorough success, there are large and well adapted lakes here in which artificial propagation would undoubtedly yield profitable returns.

MUSSELS OF THE ISOLATED LAKES.

LAKE PEPIN.

This so-called lake is really a simple widening of the Mississippi River just below Red Wing. The bottom is of fairly coarse gravel mixed with some mud, there is very little current, and the water varies from 6 or 8 to 12 or 15 feet in depth. This locality has not been fished for mussels until within a few years, but at the time of our visit there were 100 clamming outfits along the east shore of the lake, and they were averaging more than 200 pounds apiece per day.

An examination of the piles of shells collected by these fishermen yielded examples of the following species: *Lampsilis luteola, recta, fallaciosa,* and *alata, Unio gibbosus, Strophitus edentulus, Obovaria reflexa,* and *Quadrula plicata, undulata,* and *pustulosa.*

The culls were mostly razorbacks, spikes, such of the black sand shells as have a pink nacre, and a few floaters. By count about half of the commercial shells obtained are fat muckets (*luteola*), while by weight they form only 40 per cent of the entire catch.

A large number of fine pearls have been found here, nearly all of which come from the *luteolas*. One of these found just before our visit sold for $300, and another for $150. The fishermen reported the pearls not as numerous as during the previous year. They also reported another curious fact, that shells with pearls run along certain ridges on the lake bottom and are not found in the hollows along either side of the ridge.

In view of these facts it would seem advisable to propagate artificially the local commercial species, especially these thick-shelled *luteolas*, and to use this locality as a source from which to introduce desirable species into other lakes and rivers.

Mr. Andy Noel, a shell buyer for the Wisconsin Button Co. at La Crosse, took us around the lake and showed us every courtesy in the way of obtaining samples and data. Our sincere thanks are hereby acknowledged for these kind attentions.

PLEASANT AND CLEARWATER LAKES.

These lakes are situated near Annandale, in Wright County, and are connected by the Clearwater River with the Mississippi. Pleasant Lake, right in the edge of the town, is 2½ miles long and 1 mile wide, with a gravelly and sandy bottom, comparatively free from vegetation. Shells of the pocketbook (*ventricosa*) and *Anodonta pepiniana* were obtained here. The former proved to be excellent button material, but was very scarce. It was reported, however, to have been abundant during the previous year, but had been killed or driven into deeper water by the ice.

Clearwater Lake is 4 miles from town and is much larger than Pleasant Lake, being 7½ miles long and 1½ miles wide. The southeastern end of the lake is wider and deeper and has rocky shores; the northwestern half is narrower, shallower, and so lined with reeds and rushes that it is impossible to get anywhere near the shore in most places.

The fat mucket (*luteola*) was found here, in addition to the pocketbook and *A. pepiniana*. Both the mucket and the pocketbook are large and thick and make excellent button material.

The Clearwater River flows through the lake and was reported to be full of fine shells. This lake and river would yield a carload of first grade mussels, which could be readily floated down to the town of Clearwater, on the bank of the Mississippi, and shipped from there. Also the local species might well be propagated at the lower end of the lake and in the river, while in the muddier bottom at the

upper end of the lake it is probable that some of the pig-toes (*Quadrula*) would thrive well.

It is very doubtful whether any recommendations can be made for Pleasant Lake.

PULASKI, BUFFALO, RICE, AND KORONIS LAKES.

These four lakes are connected with the Crow River, but the outlets are very small streams, and those of the first two are open only during spring freshets.

Lake Pulaski is nearly circular in outline, about 1½ miles in diameter, with a bottom composed of gravel and sand, covered with a heavy growth of *Chara*, *Potomageton*, and algæ.

Buffalo Lake is 2½ miles long and 1 mile wide, with a maximum depth of 5 to 6 feet. There are two shallow bars across the center of the lake which are covered with rushes, and the bottom is firm sand and gravel, with very little vegetation.

Rice Lake, 6 miles northeast of Paynesville in Stearns County, is 3 miles long by 2 miles wide. The bottom is composed of much coarser gravel than in Buffalo Lake, and there is a little more *Chara* and algæ. The north fork of the Crow River runs into the southwest corner of this lake and empties out again within a short distance.

Koronis Lake, 2 miles southeast of Paynesville, is 3½ miles long and 2 miles wide, with a very irregular and precipitous shore. The bottom contains much more sand than gravel and the vegetation is very limited except at the inlet and outlet.

The fat mucket (*Lampsilis luteola*) and *Anodonta pepiniana* were found in all four lakes, and in addition *Anodontoides ferussacianus modestus* was found in Buffalo and Koronis Lakes. Most of these muckets are dwarfed, as is usual in a lake, and thin-shelled, but those from Rice Lake are full size, of good thickness and have a fair luster, and were classed as first-grade shells.

The *Anodontas* were found in regular windrows 10 or 15 feet from shore, and outside of them were the *luteolas*, in water shallow enough to obtain them by wading. The epidermis of these *luteolas* was a dark straw-yellow, and was highly polished like that of the same species from Lake Henry (p. 11).

The comparative paucity of shells in these lakes is easily explained by the fact that fish can not run into them freely at the time of year when they are infested with glochidia. The conditions in Buffalo Lake are excellent for sand-shells and species which frequent shallow bars. The thick-shelled *luteolas* from Pokegama Lake (Pine County), or Lake Pepin would undoubtedly thrive in Rice and Koronis Lakes. Lake Pulaski is not worth stocking with any kind of shells.

Each of these lakes contains an abundance of perch, bass, sunfish, crappies, and wall-eyed pike which could be seined with little trouble

and would furnish sufficient hosts for the glochidia; therefore, in case the artificial stocking of lakes proves a success, three of these lakes present good opportunities for work on commercial species.

SAUK LAKE AND SAUK RIVER.

Sauk Lake, 3 miles above Sauk Center in Stearns County, is 7 miles long and ¾ mile wide, and is thus little more than a widening of the river. It is partly natural and partly artificial, produced by a dam across the river at Sauk Center. The bottom is composed of sand and coarse gravel, covered with a profuse growth of algæ, *Chara*, *Potomageton*, and other aquatic vegetation. The only mussels found in the lake were the fat mucket (*luteola*), *Anodontoides ferussacianus modestus* and *Anodonta pepiniana*. The muckets are thin-shelled, dwarfed, and covered with a large amount of marl posteriorly. The epidermis is honey-yellow in color, highly polished, and faintly rayed. The two floaters, of course, possess no commercial value, and were found only in limited numbers.

The river was examined below the mill dam at Sauk Center, and again 3 miles above St. Cloud. The fat mucket (*luteola*), the pocketbook (*ventricosa*), and the black sand-shell (*recta*) were found in abundance at both places, and in addition near St. Cloud there were some ordinary muckets (*ligamentina*) and Anodontoides.

The fat muckets were of river size, and a small percentage were thick enough for buttons, the ordinary muckets were of large size and thick-shelled, but were somewhat spotted; the pocketbooks were exceptionally large, much flatter than usual, thick, and with a good luster, but they were also spotted, and on being tested proved to be brittle, thus rendering practically worthless material that to all appearance seemed to be as good as that from the Shell River at Menahga. The only thing worthy of comment here is the lack of a suitable fishway around the dam at Sauk Center. The effect of this is seen in the fact that although the pocketbook was common just below the dam, not one could be found in the 3 miles of river above the dam.

LAKE MINNEWASKA, LAKE OSAKIS, AND BATTLE LAKE.

Lake Minnewaska, situated at Glenwood, near the center of Pope County, is 8 miles long and 2 miles wide. The bottom is of sand and rather fine gravel, with numerous shallow sand bars along the southwestern shore. The average depth of the water is from 12 to 15 feet, and while there is an interrupted fringe of rushes along the shore line the lake itself is exceptionally clear and free from aquatic vegetation. There is no outlet except during very high water, when a small stream overflows into the Chippewa River, which is a tributary of the Minnesota River.

The lake is fed by numerous large springs in addition to several inlet streams, which drain the surrounding country. The lake contains an abundance of sunfish, perch, crappies, wall-eyes, and bass. On the northwest shore of the lake, within the city limits of Glenwood, there is a State fish hatchery under the supervision of Supt. J. A. Pinkerton. The water for the hatchery comes from one of the large springs that feed the lake, while a series of fishponds or aquaria are built in the lake along the shore. The lake was found to contain a great many mussels, which, however, possess no commercial value. These include the fat mucket (*luteola*), which is much dwarfed and thin-shelled, with an epidermis which erodes easily and turns dead white on exposure, three species of *Anodonta*, *imbecillis*, *pepiniana*, and *benedictensis*, and *Anodontoides*. The profusion of these mussels and the rapidity of their development show that there is an abundance of food in the lake.

We find, therefore, that the temperature and depth of the water, the kind of bottom, the presence of numerous shallow sand bars, the freedom from aquatic vegetation, and the abundance of suitable food combine to make this lake an ideal one for the artificial propagation of mussels, particularly the *Lampsilis* group. And, as if to complete the requisites, here is a fish hatchery, in whose interests hundreds of bass and wall-eyes are seined out of the lake every spring. Along with the game fish which are used by the hatchery there are always taken in the seine a large number of sunfish and yellow perch which are simply thrown back into the lake. What could be simpler than to supply the hatchery with gravid mussels of some valuable commercial species and impregnate these sunfish and perch with the glochidia before they are returned to the lake? Manifestly this is a rare opportunity for testing the possibilities of mussel propagation with almost no additional expense. The importance of such practical experimentation under the direction of skilled workmen can hardly be overestimated.

While in Glenwood we were rendered great assistance and were shown many courtesies by the officials at the hatchery. One of them, Mr. John Dahl, took us around the lake, gave us many data, and explained the local conditions, with which he was thoroughly conversant. Our sincere thanks are hereby returned to him and to the superintendent for these and many other favors.

Lake Osakis, situated close to Osakis, in the southwestern corner of Todd County, is 10 miles long and 3 miles wide. The bottom, the depth of the water, the presence of sand bars, and the freedom from aquatic vegetation correspond exactly to those at Lake Minnewaska. This lake also has no outlet except at very high water, and is a typical shallow lake, such as are common in glaciated regions.

There were found here the fat mucket (*luteola*), *Anodonta pepiniana* and *Anodontoides*. Some of the muckets were dwarfed and thin-shelled, but a small percentage were full-size and had moderately thick shells.

Battle Lake is in the southern central portion of Ottertail County and empties into the Red River. It is 6 miles long by 3 miles wide. It has a bottom of sand and gravel sparsely covered with aquatic vegetation, and the water is very clear and cold. The fat muckets here were small and dwarfed and approached very closely the species known as *rosacea*. They were easily eroded, and the epidermis on exposed portions of the shell became absolutely snow-white.

In addition there were two species of *Anodonta*, viz, *pepiniana* and *kennicotti*, and *Anodontoides*. All of these shells, including the muckets, were worthless from a commercial standpoint.

Neither Battle Lake nor Lake Osakis has a fish hatchery, but otherwise they possess as favorable conditions as those at Lake Minnewaska, and are as conveniently situated. Consequently, if the experiments at Lake Minnewaska proved successful, it would be an easy matter to repeat them in these two lakes.

SUMMARY.

1. Fat muckets (*Lampsilis luteola*) with exceptionally thick shells, and making first-grade button material, are plentiful in Pokegama and Cross Lakes, and in the Snake River, and also in Lake Pepin. They are not found in any of the other lakes or rivers which were examined.

2. Pocketbooks (*L. ventricosa*) of unusual size and luster are abundant in the Shell River and Twin Lakes near Menahga and elsewhere throughout the Crow Wing drainage and in the Sauk River. The Crow Wing shells are of superior quality and command a high price. Those from the Sauk River are so brittle as to render them worthless.

3. Muckets (*L. ligamentina*) are common in the Crow Wing and its tributaries and in the upper Mississippi. They are the ordinary good button material that is common in this species.

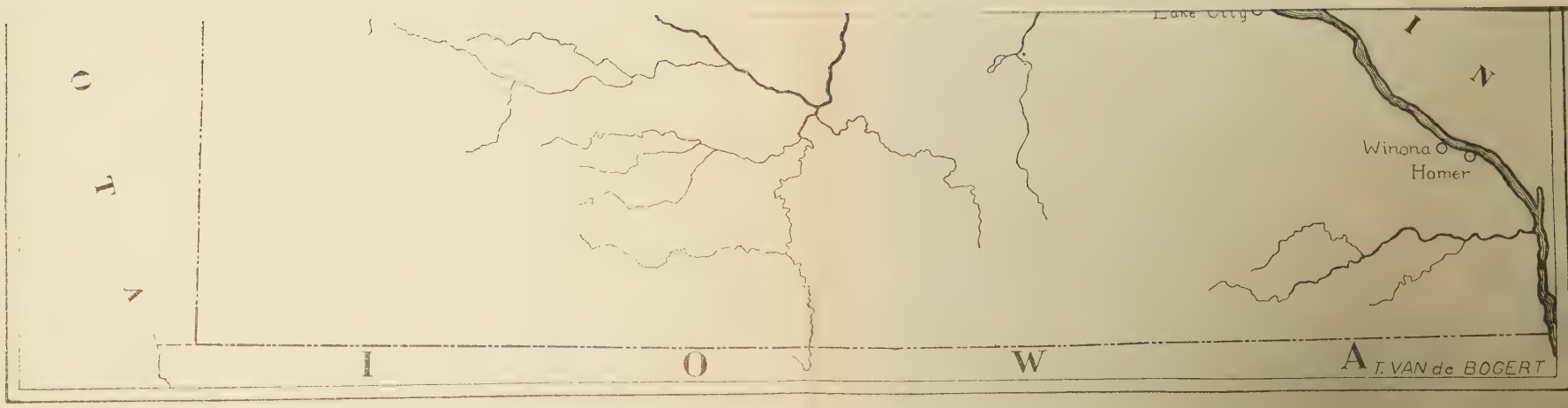
4. Black sand-shells (*L. recta*) are fairly abundant in all the rivers visited. Nearly all have purple nacre, are very thick, and make excellent material for novelties. The only exceptions are the white-nacred ones found at Menahga, which are excellent button shells.

5. Pig-toes (*Quadrula*) are found only in the St. Croix drainage and in the Red River. There are none in the Mississippi above the Falls of St. Anthony, nor in any of the other rivers and lakes visited. Some of the three-ridges were badly spotted, but all of the other pig-toes were of first quality and would make good button material.

6. Bemidji, in Beltrami County, is the best center from which to work the upper Mississippi. A blank factory situated there could

easily find material to keep it running for several years. Phelps, in Ottertail County, would make an equally good center for the Red River.

7. There are two of the recommendations which possess especial importance: First, to preserve by artificial propagation the types of shells shown in the muckets of Lake Pokegama and the pocketbooks of Menahga; second, to improve the opportunity so favorably offered at Lake Minnewaska and thoroughly try out by experiment the introduction of valuable commercial species into lakes that are specially suited to them.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THE MUSSEL RESOURCES OF THE ILLINOIS RIVER

By Ernest Danglade

Scientific Assistant, U. S. Bureau of Fisheries

Appendix VI to the Report of the U. S. Commissioner
of Fisheries for 1913

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FIG. 1.—A MUSSEL FISHERMAN.

FIG. 2.—A PEARL GATHERER AND HIS CAMP OUTFIT.

THE MUSSEL RESOURCES OF THE ILLINOIS RIVER.

By Ernest Danglade,
Scientific Assistant, U. S. Bureau of Fisheries.

INTRODUCTION.

The Bureau of Fisheries conducted a series of investigations of the Illinois River, principally during the summer months of the period extending from 1907 to 1912. The work was carried on chiefly with regard to the mussel fishery; the kinds, the quality and quantity of shells, and also the general economic conditions of the river were the important points under consideration. From 1907 to 1909 the work was in charge of Harvey L. Freeland, and during 1912 the mussel investigation of the entire river was continued by the author and John A. Danglade. For several years the Illinois State Laboratory of Natural History, with some assistance from the United States Bureau of Fisheries, conducted biological and physical investigations of the river, under the direction of Prof. S. A. Forbes.

The principal shell-producing tributaries of the Illinois are the Kankakee,[a] which has been examined and reported upon; the Fox, the report of which by John A. Eldridge accompanies this paper; the Spoon and the Sangamon, brief accounts of which are given in the body of the present report.

The United States biological station, situated at Fairport, Iowa, in charge of Dr. Robert E. Coker, furnished valuable information and suggestions, which were of great assistance to the work. The table of the commercial appraisal of shells, made by the shell expert, given on page 11, shows the condition of shells as to luster, texture, and number of gross of blanks per ton, from various representative stations of the river. The map of the Illinois and Fox Rivers, at the end of this paper, gives the principal tributaries, towns, and cities along the course, and shows to some extent the islands, lakes, sloughs, bays, etc.

The following report of the river is intended principally for the benefit of those engaged in the pearl-button industry either as manufacturers or mussel fishermen, and for others interested in the development of the mussel resources of the country.

a Wilson, Charles B., and Clark, H. Walton: The mussel fauna of the Kankakee Basin. U. S. Bureau of Fisheries Document No. 758. 1912.

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PHYSICAL CONDITIONS.

The Illinois River is one of the most important tributaries of the upper Mississippi, not only on account of the volume of water it discharges and its excellent transportation facilities, but because of its extensive fisheries and large mussel resources. The Illinois, formed by the junction of the Kankakee and Des Plaines Rivers and emptying into the Mississippi at Grafton, Ill., is about 273 miles in length. Its drainage basin comprises about 29,000 square miles of fine farm land in Illinois, Indiana, and Wisconsin. Besides receiving many important natural tributaries, it is the outlet of the Chicago Drainage Canal, having a discharge of several thousand cubic feet per second of water from Lake Michigan, and with an equivalent drainage area of 6,000 square miles. The river consequently carries an enormous amount of sewage from Chicago, as well as from the various cities and manufacturing plants along its course.

The greater part of Illinois is covered by glacial drift of varying thickness, brought down from the Northeast during the ice age, and as a consequence many of the old river beds were filled with sand and gravel and the streams were forced to cut new channels, in some places completely changing the course for all or a part of the way. Such is the case with the Illinois River. In the upper part the river has cut its way through the Wisconsin drift down into solid rock, while in the lower portion, although still in its old course, it is often as much as 100 feet above solid rock.

The watershed of the Illinois River extends in a broad band, averaging 100 miles in width, in a northeast-southwest direction directly across the center of Illinois. The western side of the watershed is 20 to 40 miles in width, while the width of the eastern side is 60 to 80 miles. From the junction westward for 50 miles, being in a new course, its bed is usually on the rock and it has an average fall of about 1 foot per mile, but in the remainder of its course it is in a preglacial channel and has a very slight fall. From the junction to Utica, its course is independent of preglacial drainage lines. About midway of its westward course it crosses the Marseilles moraine. This, no doubt, for a considerable period held a lake in the basin at the head of the river (the Morris Basin), but was eventually cut down to the level of the low part of the basin. From the Marseilles moraine westward the channel found no prominent drift barriers to remove, but has been compelled to cut down 50 to 75 feet into the rock in opening an outlet from the Morris Basin into the valley of the lower Illinois. The lower Illinois seems to have been so imperfectly filled by glacial deposits that throughout nearly its entire length the stream is reestablished in the old course. The valley of the lower Illinois ranges in width from 2½ to fully 15 miles. The narrowest portions of the lower valley are a short section at Peoria, where it passes through the Shelbyville morainic system, and a section embracing the lower 60 miles, where it traverses the Eocarboniferous and Silurian limestones.[a]

[a] Leverett, Frank: The Illinois glacial lobe. U. S. Geological Survey, mon. XXXVIII.

From its origin to Utica, a distance of about 43 miles, the river is a series of rock rapids and pools, and is practically destitute of mussels.

From Utica to Meredosia, a distance of 159 miles, the river flows through a region of but slight fall and abounds in sloughs, bays, lakes, islands, and drowned timber. The principal tributaries between these cities are the Vermilion, Mackinaw, Spoon, and Sangamon Rivers, the last-named of which produced some excellent shells this year. The river bottom of this stretch, with but few exceptions, is composed of mud or of mud and sand, which is characteristic to the mouth. From the mussel fisherman's point of view, the most important part of this section, as well as of the entire river, is Peoria Lake, which, by the dip-net method, has yielded many tons of good shells.

From Meredosia to Grafton, a distance of 71 miles, the river flows almost due south and rather close to the high bluffs on the right, except near the mouth, where it bears to the east and to the hills on the left. In this stretch there are fewer sloughs, but more islands and bars. In the vicinity of Hardin there are many productive mussel beds, with a yield second only to that of Peoria Lake.

POLLUTION OF THE ILLINOIS RIVER.

The effects of the sewage pollution of the Des Plaines River and the drainage canal upon the waters of the upper Illinois have been a subject for much discussion both to fishermen and the cities along the river. The analysis and general study of the physical conditions in the following data and tables were made under the direction of Prof. S. A. Forbes during the summer of 1911 and the spring of 1912:

During July the river between its origin and the Marseilles Dam is practically barren of fishes, bubbling with gases of decomposition, and full of floating organic matter, and the bottom is in many places deep with foul-smelling mud from which large bubbles of offensive gas escape when stirred. The character of the river changes greatly at this dam, black bass and carp coming up in some numbers to that point. During March, the organic matter of the sewage instead of being rapidly decomposed, with a nearly complete appropriation of the oxygen, as was the case last summer, is now being slowly decomposed, with a consequent gradual fall in dissolved oxygen, to Chillicothe, 93 miles down the river. At Morris there was 97 per cent of saturation in February, where last summer the average was less than 10 per cent, while at Chillicothe there is now 36 per cent where last summer there was an average of 44 per cent. Bottom conditions were similarly different. The gases of the bottom sediments at Morris last summer were largely methane, the product of organic decomposition in the absence of oxygen and the odor was that of a septic tank.

Table 1 shows the condition of the water during summer, Lake Michigan and the Kankakee River being high, while at the other places the percentage of saturation runs low. Table 2 shows the early spring conditions when the decomposition of organic matter

is very slow. Table 3 shows the percentage of carbon dioxide (CO_2), oxygen (O), carbon monoxide (CO), methane or marsh gas (CH_4), and nitrogen (N) of the river and from septic tanks during the month of September.

TABLE 1.—FREE OXYGEN, ILLINOIS WATERS: PERCENTAGE OF SATURATION, JULY 18 TO SEPTEMBER 13, 1911.

Lake Michigan	95.5	Starved Rock	37.1
Kankakee River	112.3	Peru	37.1
Des Plaines River	13.1	Depue	30.3
Morris	9.8	Hennepin	35.7
Marseilles:		Chillicothe	43.7
Above dam	7.5		
One-eighth mile below dam	65.4		
Three-fourths mile below dam	24.8		

TABLE 2.—DISSOLVED OXYGEN, ILLINOIS RIVER, MARCH, 1912.

Location.	Date.	Number of samples taken.	Temperature.	Dissolved oxygen, parts per million.	Per cent saturation.	Miles from mouth Chicago River (approx.).
			° C.			
Lockport:						
Des Plaines River	Mar. 18	3	2.5	6.5	47.5	35
Chicago Drainage Canal	...do...	3	3.0	6.3	46.7	
Morris, Illinois River:						
South shore	Mar. 19	2	1.5	10.4	73.8	65
North shore	...do...	3	1.5	9.2	65.4	
Marseilles:						
Above dam	Mar. 21	3	.0	8.8	59.8	80
Below dam	...do...	3	.0	10.0	68.0	
Chillicothe	Mar. 22	6	.0	7.2	49.0	145
Peoria:						
Above sewer outlet	Mar. 23	4	.0	6.8	46.3	165
Below sewer outlet	...do...	4	.0	6.5	44.2	
Havana	Mar. 25	4	2.0	6.2	44.6	205
Beardstown	Mar. 26	3	1.5	7.7	54.7	240
Pearl	Mar. 27	4	2.0	9.3	67.0	285
Grafton:						
Illinois River	Mar. 28	2	3.0	9.4	69.7	325
Mississippi River	...do...	2	3.0	10.5	77.8	

TABLE 3.—GASES FROM BOTTOM SEDIMENTS, ILLINOIS RIVER, AND FROM SEPTIC TANKS OF SEWAGE SYSTEMS, SEPTEMBER, 1911.

Location.	CO_2.	O_2.	CO.	CH_4.	N_2.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Morris, Illinois River	19.45	0.00	0.69	79.30	0.56
	19.31	.00	.32	79.51	.86
	18.12	.09	.68	78.97	2.14
	21.49	.00	.30	73.00	5.21
Marseilles, Illinois River	16.85	.05	.55	82.55	.00
	18.74	.00	.00	81.28	.00
Septic:					
Collinsville	17.98	.23	.34	81.26	.00
Naperville	19.06	.00	.10	74.50	6.34
Henry, Illinois River	11.99	.44	.42	61.99	25.24
	17.76	.00	.52	80.83	.89
Averages:					
Morris	19.59	.02	.49	77.69	2.19
Marseilles	17.79	.03	.27	81.91	.00
Septic tanks	18.53	.11	.22	77.88	3.17
Henry	14.87	.22	.47	71.37	13.06
Mazon Creek	.75	.66	.55	56.44	41.61

The following table, compiled from Water-Supply Paper 239, by W. D. Collins,[a] gives the mean of 36 mineral analyses of water from the Illinois, Fox, and Sangamon Rivers. The analyses were made from August 1, 1906, to July 31, 1907. While the Illinois River water is not so high in carbonates, it is higher in sulphates and chlorine than other waters of the State. The Fox has a high percentage of magnesium.

TABLE 4.—MINERAL ANALYSES OF WATER FROM ILLINOIS, FOX, AND SANGAMON RIVERS.

	Illinois River, La Salle.	Illinois River, Peoria.	Illinois River, Kampsville.	Fox River, Ottawa.	Sangamon River, Springfield.
	Parts per million.				
Turbidity	159	43	188	94	74
Suspended matter	136	26	145	87	39
Coefficient of fineness	.8	.8	.8	1.2	.8
Silica (SiO_2)	12	12	12	11	16
Iron (Fe)	.21	.21	.27	.20	.32
Calcium (Ca)	50	49	47	60	52
Magnesium (Mg)	22	21	20	32	24
Sodium and potassium (Na and K)	16	17	20	14	16
Carbonate radicle (CO_3)	.0	.0	.0	.0	.0
Bicarbonate radicle (HCO_3)	203	198	202	275	247
Sulphate radicle (SO_4)	50	48	42	61	37
Nitrate radicle (NO_3)	6.6	7.8	4.3	4.9	3.4
Chlorine (Cl)	13	13	15	7.9	7.5
Total solids	278	271	267	335	276

Whether or not the great amount of sewage that is annually poured into the river is detrimental to the aquatic life in the lower stretches, the fact remains that from Chillicothe to near the mouth, with few exceptions, the Illinois is indeed a wonderfully productive stream in fishes and mussels, and far exceeds in these resources many rivers not having similar physical conditions.

THE MUSSEL INDUSTRY.

It is of interest to note that probably the first American freshwater shells taken for the purposes of button manufacture were derived from the Illinois River. As early as 1872 a couple of tons of mussel shells were collected from the river at Peoria, Ill., and exported to Europe. Again from the same river, at Beardstown, Ill., in 1876, a shipment of shells was made to a New York firm for manufacturing purposes. In both cases the returns were evidently insufficient to warrant a continuation of the work, due largely no doubt to the want of machinery adapted to river shells, together with the general inappreciation of the value of the material.

[a] Collins, W. D.: The quality of the surface waters of Illinois. U. S. Geological Survey, 1910.

With the exception of a few pearl hunters making their test hauls and drifting at random along the different stretches, nothing of consequence was done in the shelling industry until the spring of 1892, when work began in earnest on a fairly large scale and continued all summer, at Meredosia. However, at the close of the season, the industry was apparently dropped on this river and practically nothing was done until 1907. At that time the supply of shells was diminishing greatly on the Wabash and some other streams, and it was feared that unless new territory should be found many of the shellers were liable to be out of employment and the button factories considerably hampered thereby. As the Illinois had been previously tested and proved satisfactory, the mussel fishermen from various localities went to that river in large numbers for shells and pearls. Shelling began at once in the Beardstown district, reaching from above Grand Island, and as far down as Pearl, and during the next two years the industry extended over the greater part of the stream. The Illinois reached its maximum shell production during the season of 1909, when thousands of tons of good button shells were gathered and put in piles along the shore to await shipment.

This river has been the most productive stream per mile of any in the country, and it has been reliably stated that only two or three years ago more than 2,600 boats were engaged in the mussel fishery between Peru and Grafton. It appears that the total number now engaged would not exceed 400, and even this number is largely maintained by the new dip-net method in use at Peoria and the new field opened up in the lower district. For fishing to be profitable in a river like the Illinois, where the shells are not of the kind to command the highest prices, the yield must be relatively abundant. The price paid for the 1912 shells was from $12 to $13 per ton.

A button or blank factory was established on the Illinois at Beardstown in 1907, and the next year a second plant was located at Meredosia. At the present time (1912) along the river there are 15 factories with more than 250 machines, including 1 at Peoria, using about 4 tons of shells per week, 5 at Beardstown, 2 at Meredosia, 1 at Naples, 5 at Pearl, and 1 at Grafton.

Some of the earlier factories have changed hands a number of times; others have been dismantled and removed to other places. These factories are generally blank factories, sawing or cutting out the blanks which are sent elsewhere to be finished. The buildings are usually small frame structures, with inexpensive machinery.

CHARACTER OF THE SHELLS.

The Illinois is distinctively a washboard, blue point, and warty-back (*Quadrula*) river. The condition of the bottom, the current, and the general character of the river are well suited to the growth

and development of these species, although several other genera occur in small quantities. The principal commercial species (which are found in larger numbers than all the other kinds combined) are the blue point (*Q. undulata*), washboard (*Q. heros*), warty-back (*Q. pustulosa*), three-ridge (*Q. plicata*), pig-toe (*Q. undata*), and muckets (*L. ligamentina* and *luteola*).

The Illinois River shells are generally perfect specimens, and seldom eroded at the beaks; and, for the class, the product is exceptionally good button material. A peculiar feature, however, of the shells, particularly noticeable in the lower stretches, is their gradual reduction in size as we go down the river. From the upper limits of shell production to Beardstown, the shells are of the average size of similar species found in other rivers of the Mississippi Basin, but from Beardstown to Hardin, a distance of 70 miles, they become gradually smaller, thence slightly larger to near the mouth at Grafton. Even old shells taken from protected places show this character. What causes this condition is not very evident. It can hardly be due to the lesser quantity of food material coming down the river from the drainage canal, or to any particular change of bottom. The quality of these smaller shells is fully as good if not better than those of the upper districts.

SCIENTIFIC AND COMMON NAMES.

The table of scientific and common names of the shells used in this report and given herewith is for the convenience of those who may desire to use the data for comparison. The nomenclature of Simpson,[a] with but few exceptions, is used, although many of the recent changes recommended by Dr. Ortmann and others will doubtless prove to be well founded.

LIST OF COMMON AND SCIENTIFIC NAMES.

Common name.	Scientific name.
Purple warty-back	Quadrula granifera (Lea).
	Quadrula tuberculata (Raf.).
Niggerhead	Quadrula ebena (Lea).
	Quadrula pyramidata (Lea).
	Quadrula plena (Lea).
	Quadrula solida (Lea).
	Quadrula coccinea (Con.).
Ohio River pig-toe	Quadrula obliqua (Lam.).
Pig-toe	Quadrula trigona (Lea).
Wabash pig-toe	Quadrula rubiginosa (Lea).
Two-horned pocketbook	Quadrula pustulata (Lea).
Warty-back	Quadrula pustulosa (Lea).
	Quadrula fragosa (Con.).

[a] Simpson, Charles T.: Synopsis of the Naiades, or pearly fresh-water mussels. Proceedings U. S. National Museum, vol. XXII, no. 1205, 1900, p. 501–1044.

Common name.	Scientific name.
Maple-leaf, stranger	Quadrula lachrymosa (Lea).
Monkey-face	Quadrula metanevra (Raf.).
Washboard	Quadrula heros (Say).
Blue-point	Quadrula undulata (Barnes).
Three-ridge	Quadrula plicata (Say).
Bull-head	Pleurobema æsopus (Green).
Elephant ear	Unio crassidens (Lea).
Lady-finger, spike	Unio gibbosus (Barnes).
Spectacle-case	Margaritana monodonta (Say).
White heel-splitter	Symphynota complanata (Barnes).
Fluted shell	Symphynota costata (Raf.).
Rock-shell, bastard, queen	Arcidens confragosus (Say).
	Anodonta corpulenta (Cooper).
Floater	Anodonta grandis (Say).
	Anodonta suborbiculata (Say).
	Anodonta imbicillis (Say).
Squaw-foot	Strophitus edentulus (Say).
Three-horned shell	Obliquaria reflexa (Raf.).
Buck-horn, pistol-grip	Tritogonia tuberculata (Barnes).
Little pocketbook	Plagiola donaciformis (Lea).
Deer-toe	Plagiola elegans (Lea).
Butterfly	Plagiola securis (Lea).
Missouri niggerhead	Obovaria ellipsis (Lea).
Paper-shell	Lampsilis lævissima (Lea).
	Lampsilis gracilis (Barnes).
Pink hatchet-back	Lampsilis alata (Say).
	Lampsilis parva (Barnes).
Black sand-shell	Lampsilis recta (Lam.).
Slough sand-shell	Lampsilis fallaciosa (Smith).
Yellow sand-shell	Lampsilis anodontoides (Lea).
Higgins-eye	Lampsilis higginsii (Lea).
	Lampsilis orbiculata (Hildreth).
Mucket	Lampsilis ligamentina (Lam.).
Fat mucket	Lampsilis luteola (Lam.).
Pocketbook	Lampsilis capax (Green).
	Lampsilis ventricosa (Barnes).

COMMERCIAL APPRAISAL OF QUANTITY OF SHELLS.

The following table shows, in a general way, the number of shells to a given weight at four representative stations where the difference in size was very evident. The computation is based upon counts of 10 pounds of shells in each case, and the figures represent the number of pairs of shells. At Chillicothe the shells for the test were from a 65-ton pile; at Meredosia, from a 10-ton pile; at Florence, from a 16-ton pile; and at Hardin, from a 5-ton pile. The mixed shells were other commercial species taken from the same piles. The decrease in size between the shells from Chillicothe and those from Hardin is more than 50 per cent for the washboards and three-ridges, and slightly more than 25 per cent for the blue-points.

TABLE 5.—NUMBER OF SHELLS OF DIFFERENT SPECIES IN 1 TON AT FOUR REPRESENTATIVE STATIONS.

Species.	Chillicothe.	Meredosia.	Florence.	Hardin.
Washboard (*Q. heros*)	2,000	2,400	3,400	4,800
Three-ridge (*Q. plicata*)	3,000	4,800	.....	6,800
Blue-point (*Q. undulata*)	6,800	7,000	7,800	9,200
Warty-back (*Q. pustulosa*)	.....	14,200	17,200	.....
Niggerhead (*Q. ebena*)	.....	.....	7,400	.....
Lady-finger (*Q. gibbosus*)	.....	10,800	.....	.....
Mixed shells	.....	12,400	.....	21,200

The following table of the commercial appraisal of the most important shells found by the author between Peoria Lake and Beardstown was prepared by Mr. J. B. Southall, shell expert of the United States biological station, at Fairport, Iowa. Samples of the different species were weighed, and from these there were cut blanks of 16 to 30 lines diameter. The number of gross of blanks per ton of shells was then calculated. (L = line; 40 lines = an inch.)

TABLE 6.—COMMERCIAL APPRAISAL OF ILLINOIS RIVER SHELLS.

Species.	Locality.	Discoloration.	Luster.	Texture.
Three-ridge (*Q. plicata*)	Peoria above bridge	A few stained	Good	2d grade.
Blue point (*Q. undulata*)	Peoria Lake	do	do	1st grade.
Fat mucket (*L. luteola*)	Peoria above bridge	None	do	Do.
Washboard (*Q. heros*)	Peoria to Havana	A few spots	do	2d grade.
Pig-toe (*Q. trigona*)	Peoria above bridge	None	do	1st grade.
Warty-back (*Q. pustulosa*)	do	do	do	Do.
Niggerhead (*Q. ebena*)	do	do	do	Do.
Mucket (*L. ligamentina*)	Havana	Pinkish	do	Do.
Buckhorn, pistol grip (*T. tuberculata*)	Beardstown	None	do	Do.
Pocketbook (*L. ventricosa*)	Havana	do	do	2d grade.
Maple-leaf, stranger (*Q. lachrymosa*)	Peoria to Havana	do	do	1st grade.
Higgins eye (*L. higginsii*)	Meredosia	do	do	Do.
Butterfly (*P. securis*)	Peoria to Havana	A few spots	do	Do.
Slough sand shell (*L. fallaciosa*)	Peoria to Beardstown	None	do	Do.
Rock shell, bastard, queen (*A. confragosa*).	Havana	A few spots	Fair	2d grade.
Black sand shell (*L. recta*)	Peoria	.....	.....	.....
White heel splitter (*S. complanata*)	Peoria Lake	None	Good	3d grade.

Species.	Gross blanks per ton shells.				Remarks.
	16 L.	20 L.	24 L.	30 L.	
Three-ridge (*Q. plicata*)	.....	.....	480	.....	Medium to large, exterior not eroded.
Blue point (*Q. undulata*)	.....	758	.....	.....	Medium size, very good button shell.
Fat mucket (*L. luteola*)	.....	851	.....	.....	Medium to large, smooth exterior, good material.
Washboard (*Q. heros*)	200	.....	.....	326	Large, inclined to be a little chalky.
Pig-toe (*Q. trigona*)	.....	424	.....	.....	Medium to large and very thick beaks.
Warty-back (*Q. pustulosa*)	845	.....	.....	.....	Large size, very good button material.
Niggerhead (*Q. ebena*)	.....	910	.....	.....	Large, fine luster, very fine button material.
Mucket (*L. ligamentina*)	.....	1,278	.....	.....	Large, one of the best button shells.
Buckhorn, pistol grip (*T. tuberculata*)	634	.....	.....	.....	Very good button shell.
Pocketbook (*L. ventricosa*)	700	874	.....	.....	Large, inclined to be brittle.
Maple-leaf, stranger (*Q. lachrymosa*)	535	.....	.....	.....	Medium size, thick at beak, thin at tips.
Higgins eye (*L. higginsii*)	.....	256	.....	.....	Medium size, thick, good material.
Butterfly (*P. securis*)	.....	251	.....	.....	Large, heavy, good material.
Slough sand shell (*L. fallaciosa*)	.....	.....	.....	.....	Small, good for novelties, large shells good button material.
Rock shell, bastard, queen (*A. confragosa*).	.....	428	.....	.....	Large, heavy, fair button material.
Black sand shell (*L. recta*)	.....	.....	.....	.....	Some white, some purple; good for novelties.
White heel splitter (*S. complanata*)	.....	.....	.....	.....	About 30 per cent of shell good for buttons, remainder too thin.

PRICES OF SHELLS.

The price per ton of shells has varied to a considerable extent during the last few years on the Illinois, and also on different parts of the river, as well as on different rivers of the Mississippi Basin. The quality of the shells, transportation facilities, and the supply and demand are the principal determining factors. Only the very best grade of shells could find a market in 1902; all others were discarded, being left on shore and deemed entirely worthless. During the seasons of 1907 and 1908 the price ranged from $6 to $20, according to quality, and for the early season of the next year $9 was paid for all grades, excepting culls, but near the latter part of the year the price went as high as $25, which is about the maximum paid for the Illinois shells. The average price for 1912 was from $12 to $13 for the river run of marketable shells delivered on board the cars or on a barge at the river landing. There are so few niggerheads and yellow sand shells found on the Illinois that it is hardly profitable to sort them out, excepting in the lower stretch, where the percentage of the latter is large enough to do so. They then command a price from $50 to $60.

As shown by the following table taken from the United States Census Report for 1908, the mussel products of the Illinois River for that year constituted about one-sixth of the total value of the fishery products of this important stream; and, as stated on page 115 of the report, the yield of shells and pearls of this river was nearly 40 per cent of the total water product of the entire State.

Shells and pearls	$139,000
Carp	412,000
Other fishes	309,000
Total	860,000

The report also furnishes the following information concerning the fisheries products of the Mississippi River and tributaries, 1908:

Shells and pearls	$686,000
Other fisheries	2,365,000
Total	3,051,000
Ratios of Illinois River to Mississippi and tributaries:	
Shells and pearls	20 per cent.
Other fisheries	30 per cent.
Fisheries products	28 per cent.
Fisheries products, Illinois River, 1899	24,000,000 pounds.
Fisheries products, Illinois River, 1908	46,000,000 pounds.

Increase, 92 per cent.

The yield of one-fifth of the total amount of shells and pearls of the Mississippi Basin is indeed a remarkable output for one river the size of the Illinois.

PRINCIPAL MUSSEL BEDS.

For convenience in dealing with the mussel fauna of the Illinois, the river may be divided into three sections:

1. The upper river, from the origin to Chillicothe, a distance of 93 miles.

2. Peoria Lake, from Chillicothe to Peoria, a distance of 20 miles.

3. The lower river, from Peoria to Grafton, a distance of 160 miles.

Upper river.—From its origin to Utica, a distance of about 43 miles, the river flows over a sandstone bed covered with large blocks of sandstone and bowlders. The water has a very decided odor, though it has been stated that in the low water of summer, before the opening of the drainage canal, the odor was more pronounced and disagreeable than at present. The rocks at the water's edge are covered with a slimy ooze having the same odor as the water. This portion of the river is more directly affected by the drainage canal than are the lower stretches. In the process of decomposition the organic matter of the sewage abstracts the dissolved oxygen of the water and renders it unfit for aquatic life. It is practically destitute of mussels and forms an impassable barrier for fish, at least during the summer months.

From Utica to Chillicothe, a distance of 50 miles, the shells are rather scattering and but little work is carried on. Occasional camps have been located at three or four points along this stretch, but the output was small. The commercial shells are mostly the three-ridge type, washboards, warty-backs, and muckets.

At La Salle the river is about a mile from the city. The right bank is low and inclined to be swampy; the left bank opposite the bridge is a fairly high range of drift material. The shore line on both sides is composed of mud with patches of sand and gravel. A peculiar slimy, tanky odor is noticeable at this point. No musseling is done, although a young man stated that last year he had done some pearling. According to his report, both the shells and pearls were very scarce.

At Hennepin there is a fairly good mussel bed; at Henry there are two, one above and the other below the dam; there is also a small bed on the right bank a quarter of a mile below the dam, but no shelling was being done on this bed.

The following table represents the percentages of the commercial shells from a 3-ton pile at Henry:

	Per cent.
Blue point	40
Mucket	20
Washboard	15
Three-ridge	10
Warty-back	5
Pig-toe	5
All others	5

The washboards are large, but badly spotted; the muckets and blue points have good luster and are good button shells.

At the present time it is a hard day's work to get 500 pounds of shells, while but a few years ago a man could dig a ton per day.

The bed above the dam has a depth of water from 10 to 20 feet and rather high mud banks. The current is about 2 miles per hour. An hour's work with bars and hooks on this bed yielded 128 shells, as follows:

Blue point	60	Pink hatchet-back	2
Mucket	25	Floater	2
Three-ridge	10	Buckhorn	1
Warty-back	5	Slough sand-shell	1
Pig-toe	5	Deer-toe	1
Washboard	4	Squaw-foot	1
Paper-shell	4	Lady-finger	1
Maple-leaf	2	Total	128
Rock-shell	2		
White heel-splitter	2		

There are a few small beds, 2 to 3 acres in extent, between Lacon and Chillicothe, yielding mostly washboards and three-ridges.

Peoria Lake.—From Chillicothe to Peoria, a distance of 20 miles, the river broadens into a lakelike expanse, called Peoria Lake, having a varying width of from a few hundred yards to nearly 2 miles. The slow current, the large volume of water, the good average depth and soft mud bottom are suitable for mussel growth, and there are consequently many fine mussel beds and an enormous quantity of shells, making this at present probably one of the best mussel-producing districts in the United States. Although the bottom is covered with dead shells, there have been taken, during the latter part of 1911 and the season of 1912, many tons of good shells by the lately devised dip-net method. Just what has caused the mortality of so many shells at this point and elsewhere on the river is not known. When the dip-net is brought up and the catch is emptied into the boat, the shells are sorted, the dead ones being thrown back into the river, thus keeping the bottom continually covered with them.

It is difficult to state where the mussel beds are located in Peoria Lake; in fact, they appear to be pretty well distributed over the entire bottom. Certain localities, however, are much more productive, while they vary to a considerable extent in abundance of species.

At Chillicothe there was on shore a 65-ton pile of shells, taken from the local beds, with the following percentages: Blue points 50 per cent, washboards 25 per cent, mixed shells 25 per cent, the latter consisting mostly of three-ridges, muckets, warty-backs, pig-toes, slough sand-shells, and rock-shells. On the entire pile not more than two or three niggerheads were seen. The washboards were tolerably

spotted, but hardly so much as at Henry; the blue points were rather small and thin posteriorly.

There is a good bed, extending from a mile above the railroad bridge to 300 yards below, having a width nearly that of the river. The current is about 2 miles per hour; the bottom clay and sand; the banks low on both sides, and the depth of the water 12 to 15 feet. The following is the result of a two-bar haul over the lower end of this bed:

Blue point	61	Black sand-shell	3
Fat mucket	25	Slough sand-shell	3
Washboard	24	Rock-shell	2
Three-ridge	22	Niggerhead	1
Lady-finger	22	Maple-leaf	1
Warty-back	17	Purple warty-back	1
Pig-toe	17	Elephant-ear	1
Mucket	12	Paper-shell	1
Three-horned shell	7	Total	223
Butterfly	3		

Formerly niggerheads would average 10 to 12 per haul, but now only an occasional one is found. This bed does fairly well on rising water, yielding about 500 per day.

Opposite and extending below Chillicothe, there is a small bed, 100 yards by one-half mile, but it was not being worked much this year. During 1911 a $3,000 pearl was found at this place.

A mile above Rome there is a good mussel bed, but as it is full of hang-ups, little shelling was done. We lost our bar on the first haul and were compelled to abandon this place. Just below, another good bed, one-fourth by 1 mile, yields mostly washboards and blue points.

There is also a fine little bed, 25 feet by 300 yards, 1 mile below Rome, but since it has scarcely been touched, it is covered with trash and water plants. The yield is largely blue points and three-ridges.

At Sand Beach Bar, a mile above Spring Bay, there is a small bed, 200 yards by one-fourth mile. The bottom is composed of soft mud, with some sand and many dead shells. A series of dip-net hauls showed but a small percentage of shells, mostly blue points and pig-toes. On account of the dams and the excess of water from the drainage canal, this bar is covered by water the entire year. On many low points and banks there is considerable drowned timber, due to the same cause.

There is an excellent bed, one-fourth by 1½ miles, at the narrows below Spring Bay. The bottom is soft mud, clay, and dead shells; depth of water 8 to 10 feet; fair current. A comparison of two hauls, one made with an ordinary mussel bar of 98 hooks, distance 50 yards, and the other with an 18-inch dip net, 50-yard circle, is given in table 7.

The bar caught 136 shells of 11 species; with the dip net the result was 74 live shells of 18 species. The first, however, produced nearly twice the number of commercial shells, but it took more than twice the time to make the haul; also the shells had to be taken one by one from the hooks, while the dip net was dumped at once into the boat, and the trash and dead shells were thrown back.

Mr. Oscar Nash, who assisted in the work on this bed, stated that in 1909 he obtained here 14 tons in 17 days and sold them for $18 per ton.

TABLE 7.—COMPARISON OF HAULS MADE WITH THE DIP NET AND THE MUSSEL BARS.

Species.	Number of shells.		Species	Number of shells.	
	Dip net.	Bar.		Dip net.	Bar.
Blue point	44	102	Paper shell	1	1
Three-ridge[a]	3	15	Rock shell	2	.....
Warty-back	1	3	Maple-leaf	1	.....
Washboard[a]	1	1	Black sand shell	1	.....
Pig-toe	1	6	Deer-toe	2	1
Lady finger	4	2	*Anodonta imbecillis*	1	.....
Mucket	.....	2	*Anodonta corpulenta*	1	.....
Fat mucket	1	.....	*Plagiola donaciformis*	1	.....
Three-horned shell	6	2	*Quadrula fragosa*	1	.....
White heel splitter	.....	1			
Pink hatchet back	2	.....	Total	74	136

[a] The washboards and three-ridges are found mostly in the channel.

On the Mossville Flats, just below the narrows, there were four camps in operation, and about 30 tons of good shells, largely blue points, and muckets, with fewer washboards, and some pig-toes. The washboards are very good and but little spotted. In this vicinity one man with a dip net can dig 1,000 to 1,200 pounds in half a day. It is claimed that some beds here have not been even touched.

At the present time Peoria is a great center of shell production. During the mussel-fishing season men from various parts of the river go there fully equipped to work, as the dip net can be used advantageously and the yield is exceptionally good. There were many camps at Gatlin's landing and from 80 to 100 tons of shells on shore. A similar condition exists just above this place, at Averyville. One shell buyer stated that he had purchased 600 tons at these two places last year and would at least equal it this season.

The percentages of the different species of the different camps vary considerably according to the part of the lake fished. One camp of six to eight tons had the following percentages of shells:

	Per cent.
Blue point	65
Three-ridge	15
Mucket	7
Washboard	5
Pig-toe	3
All others	5

The shells grouped under "All others" include white heel splitters, slough sand shells, etc.

The bed just above the upper bridge at Peoria was examined. On account of the bottom not being suitable for the dip net, the ordinary bars were used. Thirty species were found, the percentages of commercial shells of which are as follows:

	Per cent.
Blue point	50
Three-ridge	8
Mucket	10
Fat mucket	10
Washboard	10
Pig-toe	5
All others	7

A day's work, including cooking, will produce 700 pounds of shells from this bed. When the dip net and a good gasoline boat are used on favorable bottoms much better results are obtained.

Lower river.—That part of the Illinois from Peoria to Grafton may, for the purposes of this discussion, be designated as the lower river, which is conveniently divided into two sections, the first from Peoria to Kampsville and the second from the latter place to the mouth.

First section: Between Peoria and the Government Locks at Kampsville, a distance of 128 miles, the mussel supply is very poor as compared with the output of two or three years ago. Although many tons of good shells are still being taken, the river shows marks of depletion.

There are five tolerably well-established beds between Peoria and Pekin, but they were not worked to any extent during the present season, probably on account of the nearness of Peoria Lake and the better results obtained in that region, where the dip net is used to good advantage. In 1910 there were 25 shellers at work on these beds, 10 in 1911, and but 1 or 2 in 1912. The first bed below Peoria extends from Kickapoo Point to Wesley; the second from Willow Point to within one-half mile above Seven-Mile Island; the third from the foot of this island and extending down 1½ miles; the fourth from the river road to within three-quarters of a mile of the bridge at Pekin; and the fifth from the "day mark" to the bridge at Pekin, a distance of one-half mile.[a] During the early part of this season (1912), Mr. Lemm gathered from these beds about 10 tons of good shells, of which 60 per cent were blue points, 25 per cent washboards, 10 per cent three-ridges, and all others 5 per cent. The washboards were exceptionally good.

Although there are several good mussel beds between Pekin and Havana, but little shelling has been done. The bottom is composed

[a] Mr. Herman Lemm, of Pekin, Ill., furnished the information concerning the location of these beds.

of mud and sand, covered more or less with dead shells and trash. At the mouth of Mackinaw River the bottom was soft mud and practically without mussels. The water had a very bad odor, due to sewage pollution. In reference to the soft-mud bottoms, Mr. Freeland states: "I jumped from the front end of a launch near Copperas Creek Locks and sank into the mud almost to my hips. At the mouth of Old Crow Creek at Chillicothe, at the mouth of the Mackinaw River below Pekin, above Copperas Creek Locks and Dam at Liverpool, and in the narrow reach between Liverpool and Havana this condition exists, not only near the shore, but all the way across the river. At Liverpool the weight on the sounding line sank into the mud at the middle of the river when attempts were made to ascertain water depths." The percentages of shells of this stretch are about as follows:

	Per cent.
Blue point and three-ridge	36
Warty-back	30
Washboard	5
Mucket	4
Others	8
Noncommercial	17

At Havana there were five or six camps with about 30 tons of good shells, which were taken mostly from the beds below the city where the washboards predominate. The percentages of shells are about as follows:

	Per cent.
Washboard	50
Blue point	45
Others	5

The mixed shells were the black sand shells (some of which had a white nacre, others being deeply colored), yellow sand shells, warty-backs, pig-toes, buckhorns, rock shells, higgins eyes, deer-toes, and pocketbooks.

In company with Mr. Henry C. Allen we examined the beds in the vicinity of Havana with the dip net. Above the mouth of Spoon River a small bed 2 to 3 acres in extent is fairly productive. The bottom is mud, there is a 2-mile current, and the depth of the water is 8 feet. Several hauls were made, showing 75 per cent of blue points and 17 per cent of noncommercial shells. There were also many dead shells.

Another bed, with the same bottom conditions, but with many more dead shells—especially noticeable in the older washboards—and thousands of live snails, is located at the head of Cooks Island. The percentage of this bed is: Blue points, 35; three-ridges, 24; warty-backs, 12; rock shells, 8; maple leaves, 7; slough sand shells, 7; washboards, 4; and others, 3.

The bed at the mouth of Quiver Lake showed that fully 90 per cent of the shells were dead. The only live ones found were of the three-ridge type and small washboards, 2 to 2½ inches in length. It is difficult to state just what has killed the shells at this point, although the young washboards, 2 to 3 years old, were strong and vigorous, indicating that more favorable conditions exist at present. The east shore, especially on the lower course of the lake, is sandy, and on digging a few inches into the sand clear, cold water was found, coming from the uplands. The west shore is low, and since the building of the drainage canal all kinds of timber on overflowed lands—acres upon acres—have been killed, due to high water the entire year.

A small bed of the three-ridge and floater types extends from Cooks Island to the railroad piers. The depth of the water is 8 to 20 feet and there is a fair current. This bed, especially on the lower end, has a very poor output.

Formerly the mussel beds in the vicinity of Bath were perhaps the most productive ones of the entire river. Hundreds of tons of good shells were gathered and shipped from there. The industry, however, has dwindled to such an extent that at the present time there are only six camps in operation, with about 50 tons on shore.

The beds above Grand Island, though fairly productive, could be restored to a considerable extent by propagation. The bottom is of hard mud, the current is fair, and the shores are low mud banks covered more or less with timber. In testing these beds, as well as those down the right chute of the island, two bars of 90 hooks each, were used. These beds gave the following percentages of shells:

	Per cent.
Warty-back	31
Blue point	19
Maple-leaf	10
Washboard	9
Others	17
Noncommercial	14

In the right chute, the conditions are somewhat better, though there are more trash, hang-ups, and dead shells. About halfway down, the bottom for a short distance is mostly sand and as a consequence the epidermis of the shells is inclined to be yellowish. A washboard, conspicuous by having a pronounced ridge and valley running diagonally from the umbone toward the posterior end was taken in one of these hauls. On opening the shell, the mantle at the tip contained a 10-grain hightop pearl of good luster, but badly discolored on the base. These beds had warty-backs, 38 per cent; blue point, 16 per cent; washboards, 11 per cent; other commercial shells, 15 per cent; and noncommercial shells, 20 per cent.

Matanzas Bay, above Bath, is being worked with dip nets. Ninety per cent of the commercial shells are blue-points. There are, however, many paper-shells and *Anodontas*, and many dead shells.

The beds at Beardstown have been extensively worked, and though fairly productive, 500 pounds of shells per day of 10 hours' labor with a gasoline boat is considered a good catch. Fifteen to twenty boats were working there, and the five button factories use the shells of the locality. Although the output is not good, there are three reasons why these beds are being so heavily worked, namely, the fair amount of pearl finds, the nearness to home, and the ready market.

An estimation of percentages from a 25-ton pile of freshly dug shells shows washboards, 35 per cent; blue-points, 24 per cent; warty-backs, 18 per cent; three-ridges, 8 per cent; all others, 15 per cent. Though smaller than the same species above Beardstown, the washboards are exceptionally good in this pile.

A series of test hauls of 200 yards each were made with the mussel bar on the 5-mile bed at Beardstown, beginning above the railroad bridge and extending 1 mile below. The bottom is sand and mud; the depth in channel, 10 to 20 feet; there is a 2-mile current, and the banks are low. This bed has washboards, 25 per cent; warty-backs, 19 per cent; blue-points, 11 per cent; pig-toes, 10 per cent; others, 12 per cent; and noncommercial shells, 23 per cent.

On the right bank below the bridge the washboards are more abundant, but, owing to so many snags and hang-ups, it is deemed inadvisable to work at that point. The niggerheads are scarce, though they are reported to have been plentiful some years ago. The spikes or lady-fingers are abundant. The washboards are but little spotted and are good button shells.

In the bay above Beardstown the washboards are more spotted and not so desirable for commercial purposes.

Three miles above La Grange Locks there is a small bed, one-half mile in length and practically as wide as the river, excepting in the channel. The river conditions are as follows: Current, 1 mile; 8 to 12 feet deep; mud bottom. On this bed the washboards are nearer to the shore, while the smaller shells are farther out. This and the two beds just below yield about 200 pounds per day, with bar. Very few pearls and slugs are found. The percentages of commercial species of these beds were determined from camps situated 3, 2, and 1 miles respectively, above the locks: washboards, 50 per cent; blue points, 20 per cent; three-ridges, 10 per cent; warty-backs, 10 per cent; and others, 10 per cent. The washboards are very good.

A bed beginning a little below the locks and extending to Meredosia, although fairly productive, was being fished but very little. The shells are pretty well distributed, except in the channel. The river

conditions at this point are: Slow current; 8 to 15 feet deep; and bottom of clay, mud, and sand. The pocketbooks, pig-toes, and purple warty-backs were somewhat more abundant than in the preceding beds. It was stated that some years ago the niggerheads, yellow sand shells, and muckets were plentiful. There is a large percentage of lady-fingers, which when caught are generally thrown back into the river.

At Meredosia the mussel fishermen were discouraged and stated that "the river is playing out." Several camps were considering the advisability of moving to more favorable localities, either on the Illinois or Mississippi. Although the output—200 to 300 pounds of shells per day—was small, the number of good pearl finds afforded considerable stimulation to the work. During 1909 there were 200 men at work between Meredosia and Naples, and they gathered 100 carloads, the price being $25 a ton,[a] while in 1912 there were but 25 to 35 men gathering 15 carloads at $13 per ton. There were about 400 tons in the hands of the buyers and 250 tons at the two button factories. In this stretch of the river the niggerheads and muckets are scarce, but there is an abundance of lady-fingers. The washboards here, being clear of spots, are the best button material, and the next best are the blue points and warty-backs. The few niggerheads found are thin.

At Valley City there were 10 to 12 men working on the local beds, the output not exceeding 300 pounds. It was stated that there were many boats employed here last summer. There is a small bed, 300 to 400 yards long, situated on the left bank, one-eighth mile above the railroad bridge. This bed is covered more or less with trash and hang-ups, thereby making it remarkably interesting, in that it is practically in its native state. It contains 18 species of commercial shells, including a fair percentage of niggerheads, pocketbooks, and muckets.

Although early in the season, 40 men were fishing on the mussel beds in the vicinity of Florence, while but 9 were engaged in July. Forty tons of 1912 shells had already been shipped and half that amount were on shore. The following percentages were determined from a number of hauls made at Florence, two bars of 100 hooks each being used; the bottom, sand and mud with brush and dead shells.

	Per cent.
Blue point	24
Washboard	20
Warty-back	18
Pig-toe	9
Others	21
Noncommercial	8

[a] Kappel Bros., Meredosia, Ill.

Only one each of elephant-ear and squaw-foot were found; the lady-fingers were smaller and much less abundant than at Meredosia and Valley City. This bed will yield 200 to 300 pounds per day per man.

There are good beds on both sides of the river practically all the way from Florence to Montezuma. At the latter place, 12 tons of shells had been shipped this year, and 5 tons remained on shore. There were two to four men working on the mussel beds, getting 200 to 300 pounds per day. It was stated that two years ago there were 30 to 40 boats in operation, and 200 tons were shipped. The percentages of the shells are about as at Florence.

From Bedford 15 to 20 tons had been shipped by the middle of July and 8 tons were on shore. There were 10 boats at work, the yield being 300 to 400 pounds. The shells are the usual run, however, some beds have as much as 5 per cent of muckets, while on others the lady-fingers appear to be associated with the washboards.

A few years ago Pearl, like Bath, was a great mussel center. Then there were 300 to 400 men working on the bed, beginning near Bedford and extending in zigzag lines for 15 miles down the channel of the river. At the present time (1912) there are 30 men engaged in the mussel fishery, and they have gathered 10 to 12 carloads of good commercial shells; but the conditions have so changed and the outlook is so unfavorable that some of the local button factories are anxious for new territory.

Near shore, in the left chute at the foot of Spar Island, 3 miles below Pearl, there is a good productive bed yielding mostly rather large washboards, a fair percentage of blue points, and a few muckets. This bed has a mud bottom somewhat covered with trash, and is best worked by wading and diving. Near the shore line fully 75 per cent of the shells were slough sand shells, burrowed in the mud and standing on end.

The camps at Gravel Point, Webbs Landing, and Woods Creek Landing had 15 boats in operation, with an output of 30 tons. The shells in this stretch are of the usual run, though there is a smaller percentage of culls, such as lady-fingers and paper shells. The washboards are exceptionally good.

TABLE 8.—PERCENTAGES OF DIFFERENT SPECIES OF MUSSELS AT SIX STATIONS IN THE LOWER STRETCHES OF THE RIVER.

Species.	Above Grand Island.	Right Chute, Grand Island.	Beardstown.	Florence.	Hardin.	Grafton.
Niggerhead	1	×	×	×	4	32
Ohio River pig-toe	1	1	×	×	2	×
Pig-toe	4	3	10	9	2	1
Warty-back	31	38	19	18	13	3
Maple-leaf	10	2	3	2	×	3
Washboard	9	11	25	20	23	15
Blue-point	19	16	11	24	20	20
Three-ridge	4	4	4	5	11	×
Lady-finger	5	15	20	5	13	1
Three-horned shell	4	2	1	7	3	1
Buck-horn	×	1	1	×	×	1
Deer-toe	1	2	×	×	1	×
Butterfly	×	×	×	×	×	3
Paper shell	5	1	1	1	1	×
Yellow sand shell	×	×	×	×	1	7
Other shells	5	3	4	7	5	11

NOTE.—× represents less than 1 per cent.

Second section: From Kampsville to the mouth of the Illinois at Grafton, a distance of 32 miles, the mussel conditions are much better, and the river is yielding greater quantities of shells than any other portion except the Peoria Lake region. There were about 150 boats at work in this stretch, with a daily yield of 500 to 700 pounds of shells per man.

Except in the last few miles of the lower course, the river bears closely to the right of the watershed and to the high bluffs and wooded hills, and consequently becomes very picturesque in appearance.

Above the Government locks at Kampsville 10 men were engaged in mussel fishing, each obtaining 300 to 500 pounds per day. There were 30 tons on shore. The last bed above the locks extends almost to the dam and is more productive on the lower end, probably due to the fact that but little work had been done there on account of the danger. The beds produce washboards, 45 per cent; blue points, 21 per cent; warty-backs, 20 per cent; while just below the dam the yield is not so large, yet the pearl finds will probably more than make up the difference.

Below the Kampsville locks (the last in the river) the water is swifter, and the stream is in its natural condition. The shells are about the same as above, but near the dam there are more pocketbooks (*L. ventricosa* and *capax*) and fat muckets. Some beds also have a large percentage of lady-fingers. On July 3 a sheller working the bed below the locks unguardedly ran his boat into the falls of the dam and was drowned.

From Willow Island to the foot of Hurricane Island there were 30 boats in operation, and very good results were obtained. Both sides of the latter island have good productive beds; the catch,

especially in the channel, is: Washboards, 75 per cent; blue points, 10 per cent; and warty-backs, 10 per cent. A good 32-grain pearl was found in this stretch during the summer.

There were four camps and 26 tons of shells on shore in the dark or right chute of Diamond Island. This chute is deep, narrow, and has a number of hang-ups. No shelling is done here on Mondays on account of the large steamboat which makes a round trip then from St. Louis to Kampsville. In going through this chute the steamboat makes such large and dangerous waves that no small craft there could keep from sinking. Twenty-eight species in all were taken here, including the only spectacle-case (*M. monodonta*) taken during the entire trip. The shells are largely washboards of excellent quality, and but few lady-fingers. The bed affords 400 to 600 pounds per day per man. The left or light chute is much shallower and the beds have a good yield of commercial shells.

At Hardin there were from 60 to 100 gasoline boats at work on the mussel beds, the yield being from 400 to 700 pounds of good quality shells. Probably by the latter part of July as many as 1,000 tons had been shipped from there, about one-third of the amount going to Canadian factories. It appears that Hardin would be an excellent location for a button factory, the raw material being so abundant and near at hand. A number of good pearls were found this year, the most valuable one selling for $750.

A series of test hauls were made, beginning at the foot of Diamond Island and extending to Hardin. The mussel bar and crow-foot hooks were used. From this bed 34 species were taken, also a number of dead shells. The percentage was:

Washboard	23
Blue-point	20
Warty-back	13
Three ridge	11
Niggerhead	4
Pig-toe	2
Others	13
Noncommercial	14

In that part of the Illinois from Hardin to Grafton at the mouth, a distance of 20 miles, there are practically no places for accommodations in the way of lodging, and it was necessary to make the survey of the interesting district in one continuous run, from early morning until late at night. There are a number of good and productive mussel beds in this region, with the exception of the last few miles of the river.

In the left chute of Mortland Island the yield of shells is 400 to 600 pounds per man per day. There are 12 to 15 camps within 2 miles of each other, and 90 to 100 tons have been taken this year. The shells are of the usual run of those found in this stretch, though the

washboards are very small and there are fewer culls, such as lady-fingers.

At Twelve-mile Island there were four camps in operation, two on each side of the island, the average daily yield being from 400 to 600 pounds per man. Early in the season the upper camp of the right chute took 1,200 to 1,800 pounds per day, which was very good work indeed with the mussel bar and crow-foot hooks. The lower camps, during the earlier part of the season were overflowed, and work accordingly could not be carried on; however, when the conditions became more favorable, two men gathered 30 tons of good marketable shells in eight weeks. The mussel beds in the vicinity of this island produce about 65 per cent of washboards, 20 per cent of the three-ridge type, a very small percentage of niggerheads, and a sufficient quantity of yellow sand-shells to be sorted out and sold separately at an advanced price of from $50 to $60 per ton. The lady-fingers and other noncommercial shells are not very plentiful in this district.

In the last productive stretch of the river there are 10 to 15 mussel camps in operation, the daily output being 500 to 600 pounds, which is somewhat less than the immediate shelling districts above. The shells of the three-ridge type are more abundant, though there are fewer warty-backs; the washboards have again become a trifle larger than at Hardin, but they are not quite so good from a commercial standpoint, as they are inclined to be spotted.

As a comparison of the Illinois River product with that of the Mississippi, the percentages given in the brief table below were made from a 2-ton pile of recently gathered shells taken in the Mississippi at Grafton, just below the mouth of the Illinois. It will be observed that the niggerheads are relatively abundant and that there is a fair amount of yellow sand-shells.

	Per cent.
Niggerhead	32
Blue point	20
Washboard	15
Yellow sand-shell	7
Warty-back	3
Butterfly	3
Maple-leaf	3
Others, including culls, etc	17

Tributaries.—The tributaries of the Illinois, as a rule, produce a superior grade of shells and a larger per cent of pearls and slugs than the main stream. A serious disadvantage, however, of the smaller rivers is that, especially during the low water of summer, the mussel beds are liable to be almost completely depleted by waders, either pearlers or shellers.

Spoon River.—No extended investigations were conducted on the Spoon River during the present survey; however, a short trip was

made in the lower stretches, which did not reveal very satisfactory conditions for mussel beds. The banks are composed of drift or mud, and the low bottoms are subject to overflow in times of high water. The river is very crooked, with numerous large bends and a considerable number of cuts and corresponding fills and bars on the opposite side. It is practically a depleted stream, as relates to the mussel fishery, though the upper portions are more favorable for mussel beds, and it is a question whether it would be profitable to restock it or carry on propagation work to any extent, as it is so readily exhausted in a season or two by pearl hunters and others.

There have been recorded, 20 years ago, from the Spoon River, about 38 species of the Unionidæ.[a] The commercial species listed in the general table of species on page 37 were from a pearl hunter's pile of shells taken from the upper river during the present season. The shells were excellent in quality, and large in comparison with those of the Illinois. Some of the washboards (*Q. heros*) were so large that they would hardly fit into an ordinary hat.

Sangamon River. The Sangamon River is about 170 miles in length and has a drainage basin of 5,670 square miles, which is the largest of the tributaries. The lower stretch, formerly very winding and overflowing the lowlands, has been straightened by means of a ditch.

The general conditions of this river, with its many favorable places for beds, are good for mussel development, and the propagation of the better species could be easily carried on and the river made to yield a reasonable annual return, provided it were judiciously fished. A station was made near Springfield, Ill., and the commercial shells found there are listed on page 37. The shells are of a better grade than those of the main stream, and the muckets, niggerheads, and buckhorns are more abundant. About 100 tons of good shells have been gathered this year, with a daily output of 400 to 500 pounds. A number of fine pearls and slugs were found, and all were generally of a rather good grade. The river appears to be fairly well cleaned out.

DEAD MUSSEL BEDS.

At several places on the Illinois, more particularly noticeable in the lower stretches, there are evidences here and there of old covered-up mussel beds which lie several feet below the surface. The keeper of the Government locks at La Grange stated that at the time of building the locks, when extensive excavation was done, a dead mussel bed of some extent and thickness was encountered at a short distance below the present surface, and that the shells were lying in their natural position.

[a] Strode, W. S., M. D.: The Unionidæ of Spoon River, Fulton County, Ill. The American Naturalist, vol. XXVI, 1892, p. 495–501.

Near the head of Diamond Island, situated about 2 miles above Hardin, there is exposed at low stages of the river along the shore line from below the water's edge to a foot above, an extensive bed of dead shells, as shown at A in figure 1. A similar condition exists further down the river on the right bank, as shown at B in figure 1. This is probably a continuation of the same bed. Below Hardin two additional beds are exposed where the current has undermined and cut away the banks—one bed at the head of Mortland Island extending irregularly down the left chute of the island for half a mile, and the other at the head of Twelve-mile Island.

Here, no doubt, is a situation of the destruction of large mussel beds in comparatively recent times by means of a silting or filling in

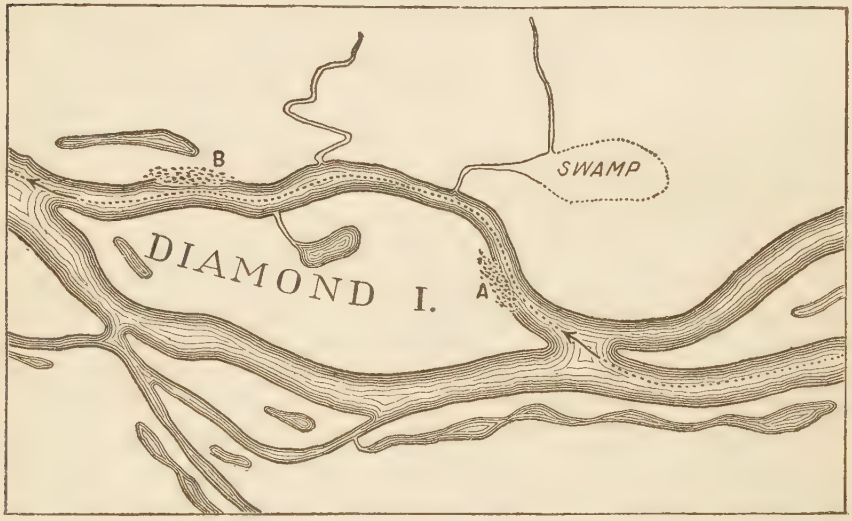


FIG. 1.

process of mud and sand. The mussels evidently could not keep pace with the settlings, as the deposit was rapidly forming, and were suffocated. The shells appear to be of the same species found in the river at those places, and are very fragile and limy white in color.

METHODS OF THE ILLINOIS MUSSEL FISHERY.

The mussel fishermen of the Illinois are, as a rule, practical rivermen who are familiar with the conditions of the river, the general habits of the fishes and mussels, and the methods of taking them, although considerable misinformation is in evidence, as, for example, the structure of the mussel, methods of reproduction, the names of the shells, the character of pearls, etc. Mr. Freeland states that the men who were first attracted to the mussel fishery of this stream were largely an indolent lot, who expected to find an easy fortune

in pearls, and in their haste to do so, generally discarded the shells as worthless, or at best only of secondary importance. During the summer of 1907 only two men were found who said that shells and not pearls were the chief object of their work. When the mussel industry reached a firm commercial basis, however, this type of men practically vanished, and was replaced by the regular fishermen, farmers who work at mussel fishing during dull seasons on the farm, the professional mussel fishermen, and by others who were attracted to the river for pleasure and profit during a summer's outing. The mussel fishermen, when at a distance from home, often live in tents or in rudely constructed houses situated at favorable places along the shore, and at times in substantial house-boats, which afford them shelter as well as an economical means of moving their outfit from place to place as the season changes or their inclination prompts.

Almost all of the shellers have gasoline boats with which to carry on their work. There are two types of boats in use -the launch, of which there are a variety of designs, and the john boat; the latter is very popular, as it is comparatively cheap, easily made, affords plenty of room, and is perhaps better adapted for handling the necessary appliances. It has a broad flat bottom, square ends, long rakes, especially forward, and is from 14 to 18 feet long. The gasoline engines are from 2 to 20 horsepower. The advantages of a power boat over the rowboat are very apparent, namely, the greater distance possible to travel in a day, the readiness with which the camps can be moved from one locality to another, and the greater quantity of shells taken.

Crow-foot bar.—The ordinary mussel bar or brail with crow-foot hooks, common on most of the commercial rivers, is the principal apparatus used on the lower two-thirds of the Illinois. The bar is usually of iron, from 12 to 16 feet in length, and from three-fourths to 1 inch in diameter. The strings carrying the hooks are placed 4 inches apart. There are two types of mules, or underwater sails, as they are sometimes called, the common solid frame type and the roll mule. The latter is generally used on this river, and has some advantages over the other, in that it can be rolled up and put out of the way when not needed, or used as a tent for protection against unfavorable weather, and it is claimed that it is better adapted to change the angle of the boat when desiring to cross the mussel bed diagonally or to avoid a known hang-up. On some parts of the river scissor forks or tongs are employed with fair success during part of the year, usually in low water. At those places where it is impossible to use any appliance on account of snags and other obstructions, and where the water is not too deep, the shells are often taken by wading or diving, but owing to the necessary exposure this method is not very popular with the mussel fishermen.

Dip net.—Since the time that the mussel fishery began on this river, it was known that Peoria Lake contained large beds of good commercial shells, but until 1911 no very successful method of taking them had been devised, scissor forks, oyster tongs, rakes, and the ordinary mussel bar with crow-foot hooks proving unsatisfactory. The dip net was introduced during the spring of that year and is now used there almost exclusively, as it is simple in construction, inexpensive, and especially suited to soft mud bottoms free from logs and hang-ups, and where there is but little or no current. Like the mussel bar, it gathers nearly everything in its path on the river bottom and even some little distance below. Besides the live and dead shells, and always plenty of mud, there are found at times in the net as the result of a haul some one or more of the following articles: Bottles, cinders, lanterns, old shoes and rubbers, folding anchors, spectacles, shotguns, pieces of musical instruments, shovels, watches and rings, jugs of gasoline, monkey wrenches, waterworks keys, tin cans, corncobs, snags, etc.

It is not known who invented this valuable apparatus, but probably the idea developed from the fish dip net, which it resembles, by gradually changing its form to the substantial tool now employed. There appear to be no two dip nets alike, as the blacksmiths make them according to orders and the material at hand. However, the various designs and patterns are very similar, the main difference being in size. The method of operation is the same for all of them. In a general way the dip net consists of a heavy, flattish iron hoop of one piece, bent somewhat triangular in form, with two of its sides curved outward and fastened firmly with bolts to a pole or handle 16 to 20 feet long. The third side or bottom is straight and from 18 to 36 inches in length, and is usually provided with coarse teeth along its edge, which is bent downward. A net of 2-inch mesh, made of small chain or no. 96 trot line with a capacity of a bushel or more, is fastened to the hoop by means of chain links and trails behind it. A short rope or bridle attached to the two curved sides of the hoop leads to a single rope secured to the bow of the boat. When the water is rather deep, the boats are fitted with a boom pole extending forward from the bow, and the rope from the bridle is fastened to its end, thus giving greater length of rope and convenience of manipulation. Driven by a gasoline engine of from 4 to 20 horsepower, according to the size and weight of the dip net, the boat draws the apparatus through the water along the bottom. The greater the power, of course, the better the results. The operator stands in the stern of the boat and steers with his foot or leg, and at the same time puts the net into the water, usually at his right side and bears down heavily on the handle. The teeth on the lower edge of the hoop dig up the mussels which roll into the net. Unless the appliance be

placed at the stern and in the direct line of travel, there is a retardation on one side only, and the boat consequently makes a large circle over the mussel beds. When the tool is raised after making a haul, the mud and small shells are washed out by dipping the net a number of times into the river; the contents are then dumped into the bottom of the boat, to be sorted out, the trash and dead shells being thrown overboard. The partner usually attends to this matter as well as

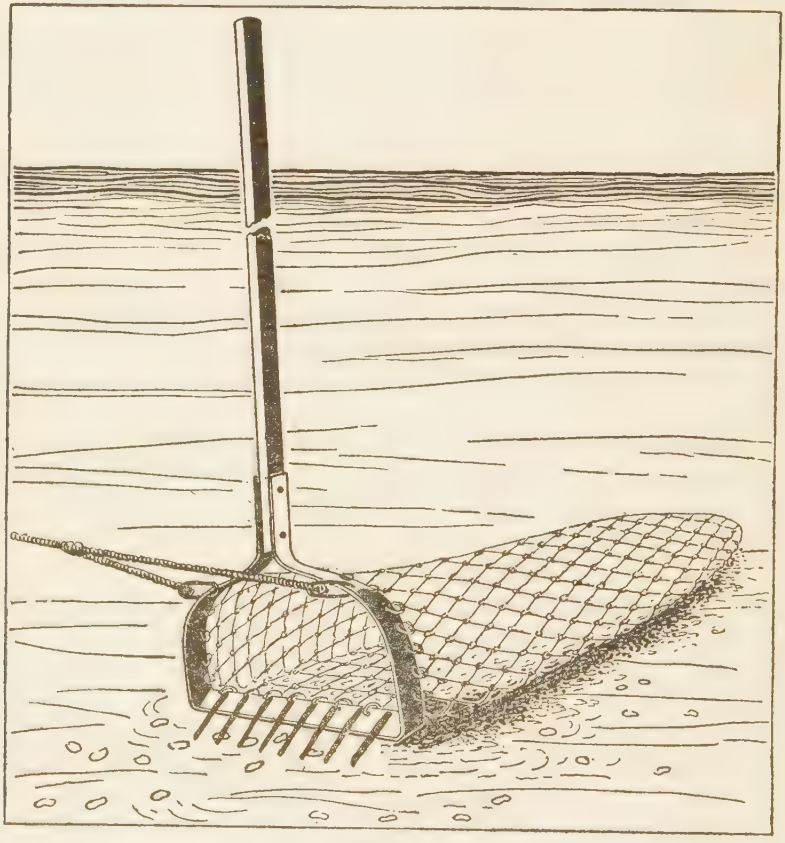


FIG. 2.

looking after the engine. By this method of mussel fishing, two men or a man and a boy can easily dig in a good locality 1,500 to 1,800 pounds of shells in half a day.

LEGISLATION.

The legislature of Illinois has recently enacted a law looking toward the protection of mussels and the mussel fishery of the State. A closed season has been established for the navigable waters, extending from October 1 to April 1, inclusive. The boats are to be equipped with not more than two bars, which shall not exceed 16 feet in length,

the hooks thereon to be at least 4 inches apart. Nonresidents must have a license costing $50 for each boat.

In view of the threatened depletion of the mussel beds on the Illinois, it has been suggested by mussel fishermen and others interested in the industry that there should be a closed season on all the mussel-bearing rivers or parts thereof, extending over a period of three to five years; the rivers or the parts to be so arranged in series that some (sufficient to maintain the button industry) would be left open during the ordinary shelling season. It may be that this view would prove satisfactory, provided there was a uniformity of laws in the various States, or that the mussel fishing was under Federal control.

THE PEARLS OF THE ILLINOIS.

Very little pearling was done on the Illinois previous to 1892, although some years before this date occasional pearl hunters made frequent trips and extended investigations from time to time over the greater part of the river. During the earlier period pearls alone were the object of the search, there being no particular demand for the shells, and, besides, the pearler of that day had neither time nor inclination to save them; they were left after examination, usually in small piles along the shore as a waste product. If a locality in which he was working did not show immediate results he would move farther along, always hoping and expecting to find a mussel bed which would produce a pearl of considerable value, thus amply repaying him for his time and outfit. The pearl hunters are indeed the pioneers of the mussel industry, and in their extensive search for the elusive gems they have usually found not only the best mussel streams of the country but the best beds and the most productive portions of the rivers as well.

At the present time it might be said that the pearls and slugs are of secondary consideration and when found are regarded by the mussel fishermen as so much clear profit. The sale of slugs is generally sufficient to meet the actual running expenses of the camp and a pearl is considered as so much extra.

Beardstown, Ill., is a center for pearl buyers, and during the shelling season buyers are there from Paris, New York, and other places, besides the local dealers. One man claimed to have bought $20,000 worth of pearls and slugs along this river in 20 days.[a]

No particular work was done during the present survey toward the study of the origin of pearls; however, a number of distomids and cyst-forming parasites were observed in the meats of the mussels. The Illinois is a good river on which to carry on scientific pearl investigations, as it is rich in pearl mussels and affords many retired places

[a] The writer is indebted to Messrs. J. H. Carner and Otto H. Fischer, of Beardstown, who furnished much information concerning the pearls and slugs of Illinois.

and favorable mussel beds especially suited to pearl study. Among the most interesting localities for observing pearl formation and development may be mentioned Peoria Lake, Havana, Bath, Beardstown, Meredosia, Pearl, and Hardin, at which places, as well as at many others, excellent pearls have been found, and no doubt there are many more there yet to be taken.

FINDING THE PEARLS.

The cooking-out process of the mussels is an interesting and important part of the work in the camps along the Illinois. The mussels are steamed for 15 or 20 minutes in a crudely constructed vat, until the shells have opened and the meats may be readily taken out. Shells and meats are then transferred from the cooker to the sorting table, and the parts there separated, the meats being put aside temporarily and the shells thrown into a near-by bin. The meats are then carefully examined one by one—a very tedious process, but well worth the trouble.

The slugs and other minor nacreous pieces when found are dropped into a glass of water on the sorting table and are afterwards cleaned, usually with soap or soap powder. A pearl, however, being much more valuable, receives an entirely different treatment in that it is "tempered" by being placed in the mouth for a while, then wrapped loosely in cotton, and put in a small tin box or other receptacle for safe-keeping. The pearlers and pearl buyers believe that this method of treating the gems prevents cracking.

"Does the boiling or cooking-out process of mussels injure the contained pearl?" is a question that is often asked and one that has led to considerable discussion. From personal observations and from the statements of mussel fishermen and pearl buyers it appears that moderate cooking or steaming of the mussels does not injure the pearls at all, provided they do not fall out of the shells or become disengaged from the meats and thus reach the bottom of the cooker and get scorched. Some mussel fishermen who have had practical experience along this line of work maintain that moderate cooking is beneficial rather than detrimental, inasmuch as the process "cures" the organic matter of the pearl and renders it less liable to crack or otherwise to deteriorate. However that may be, it is very evident that by far the greater percentage of the pearls and slugs are found after the mussels have been cooked, the exception being for those shells which show distortion or some other peculiarity, when they are generally opened with a knife as soon as found.

CLASSIFICATION OF PEARLS.

There appears to be no definite standard or classification for the almost unlimited variety of shapes and kinds of pearls and slugs, and even on the different parts of the same river the irregular nacreous formations are variously named by the pearlers and buyers, according as fancy directs or to the resemblance to some familiar object. At times the classification is made under three heads—pearls, baroques, and slugs, each class with a number of subdivisions depending for names upon the particular shape of the pieces; and at other times there are but two heads—pearls and slugs. The following are the names and classifications generally used on the Illinois and includes most of the different kinds of pearls found there:

Pearls:

Ball or round pearls are those which are spherical in shape.

Pear pearls, including the drop, the egg, and the top pearls, depend for the name upon the resemblance in shape to a pear, egg, or top.

Button pearls, shaped somewhat like a button, biscuit, or saucer, have a more or less arched top and a flattish bottom.

Capsule pearls have a shape bearing a resemblance to a cylindrical medicine capsule such as is used for quinine.

Banded pearls are oblong in shape, with ridges and grooves around the middle portion which have the appearance of bands.

Cone pearls have a flattish bottom with the sides of the pearl running to an appex like a cone.

Baroque pearls include a great variety of forms which are irregular in shape without any particular pattern.

Rosebud pearls are of various shapes, usually having a flattish base; the upper portion is more or less covered with small protuberances, giving it at times a somewhat warty appearance.

Turtle-back pearls have a rather flat base and a low arched top, resembling somewhat the back of a turtle.

Besides these forms, there may be mentioned the dumb-bell, the cylinder, the twin pearls, etc., which are occasionally found.

Slugs:

Spikes or points, including wings, are usually placed under the head of slugs, although if they are of sufficient size they are sold as single pieces. Spikes or points are usually long, flat, and often pointed pearls found near the lateral hinge of the shell, while wings are broad, flattish pearls bearing a resemblance to the wings of a bird.

Nuggets and chunks are often classed together, with the difference that the chunks are much larger. They are irregular pearly formations resembling somewhat a gold nugget in shape.

Slugs include irregular pearls having no particular name and without much value and called "mixed;" also small or seed pearls, "chicken feed," etc. Slugs of this class are usually sold by troy weight, and are worth, according to quality, from $3 to $3.50 per ounce.

The ball, the pear, and the button pearls are the most valuable, although the capsule and some other forms often command a high price if they be symmetrical in shape and of fair size and good luster.

POSITION OF PEARLS IN MUSSEL SHELL.

Pearls are usually found in the mantle near the tip or posterior end of the mussel, while slugs and other pieces may be found in various parts of the body, along the lateral hinge, at the cardinal teeth, in the adductor muscles, and in the shell itself, etc.

Sometimes a pearl becomes attached to the shell, after which it may be covered over by deposits or layers of nacre and is then said to be embedded. These pearls can be recovered by sawing the shell around the observed protuberance or by carefully removing the inclosing layers. Many shells have what are commonly called "blisters," which are successive pearly deposits over mud, muddy water, organic matter, or some foreign substance finding its way into the mussel. It illustrates a method the animal uses to remedy a disturbance within. Blisters, as found in the Unios, have no commercial value. There are found occasionally in the meats of the mussels cartilaginous formations which are denominated by the fishermen as "soft pearls undergoing the process of formation into true pearls." It is claimed that soft pearls are caused by a grain of sand or other foreign body.

PEELING A PEARL.

As pearls are composed of thin concentric layers of nacre and conchiolin or animal substance, each separate and distinct, peeling or removing some of the outer layers of the various forms of pearls to improve the gems is often done successfully by one versed in this line of work. Pearls having a dark spot, stain, or chalky appearance over the entire surface, or even a part of it, are greatly diminished in value. When such is the case it is often worth while to try the experiment of peeling, as the result will probably be satisfactory and a good pearl obtained from within. However, it may be stated that fairly good pearls have been damaged rather than improved by peeling, as the inner layers were in a worse condition than those at the original surface. A fine, pink, high-button pearl of 40 grains and worth $800 was seen this summer. The pearl had a small spot on the side and might have been benefited by peeling, but the owner, considering its present value and the uncertainty of the result of peeling, would not take the risk.

CRIPPLED SHELLS.

Occasionally the various mussel beds of the Illinois produce a few examples of distorted or injured mussels, commonly called "crippled shells." They are regarded by the pearler as excellent finds and are generally opened at once without waiting for the cooking-out process, with the hope that a piece of some value may be present.

Those shells which have received an external injury, however, and are distorted in consequence, seldom contain anything of value; but it does appear unquestionable that other distorted shells owe their peculiar condition to the presence of a pearl; the abnormal shape is the direct result of an accommodation to the disturbing nacreous growth within, which as it slowly develops maintains its position relative to the margin of the mantle and valves. Certain shells which have come to the writer's attention contained valuable pearls as well as showing clearly the abnormal condition. As viewed from the outside, such shells have a slight and gradually broadening ridge running diagonally down from near the beak or umbone to the tip or the posterior end on one valve and a corresponding valley or depression down the other. Within the shell the opposite condition of the ridge and valley is true. From this circumstance it is possible to estimate with some degree of accuracy the age of the pearl by the lines of growth on the external surface of the shell, noting where the disturbance begins and ends. In studying these distorted shells the peculiar fact is brought out that the pearl is always on that side of the shell whose valve shows, viewed externally, the valley or depression. In a large percentage of these distorted shells the pearls have been found on the left valve. The pearl, near the margin of the mantle, causes the abnormal action of the latter, which produces the slight inward curve of the nacreous deposit, so that it might be said that the pearl lies on or near a ridge. For the opposite valve the mantle condition is reversed, resulting in the outward deflection of the nacre, or the valley.

Some of these apparently valuable crippled mussels contain no pearl whatever, although the evidence is plainly written, both within and without, in the texture of the shell. When this condition is observed, the pearls are said to have been lost or "shed." If the pearl were lost some years before the mussel was taken, the shell often recovers in part its natural shape from that time on, as shown by the lines of growth and the posterior edge or lip, and it is hardly worth the time and trouble to try to find a pearl within.

Accompanying plates show some examples of distorted or otherwise injured mussels and will assist in understanding this interesting subject.

QUALITY AND VALUE OF ILLINOIS PEARLS.

The quality of the Illinois River pearls and slugs, though very good, does not quite equal that of the pearls and slugs of the Wabash and some other tributaries of the Mississippi. Nearly all of the different species of mussels have produced pearls and slugs, but the washboard (*Quadrula heros*) is the principal pearl-bearing shell of the Illinois, and the blue-point and three-ridge (*Q. undulata* and *plicata*) are among the

best slug producers, although the warty-backs (*Q. pustulosa*) occasionally have good specimens of the latter. Some of the paper shells and floaters were observed to have a number of attached pearls, appearing for the most part at the tips or posterior ends of the shells. These pearls, as a rule, are of no value except from the standpoint of the experimenter.

The average yield of slugs for the entire river will not exceed, perhaps, one-half ounce per ton of shells, while the percentage of good pearls is very small indeed. Many valuable gems, however, have been found in this river during its shelling history. It is difficult to determine the value of the Illinois River pearls and slugs for 1912 or for previous years, as there are many buyers traveling along the stream during the shelling season who make private purchases of them, paying for the slugs from $3 to $3.50 per troy ounce. Pearls ranging in value from $5 to $25 and upward were found in 1912 at nearly all the principal mussel beds from Hennepin to below Hardin. Among the best finds may be mentioned the following: Three fine pearls were found in Peoria Lake and sold for $1,100 each, and one exceptionally fine pear pearl of beautiful luster, weighing 64 grains, sold for $2,500. One at Pearl, Ill., sold for $2,700, and one found at Hardin brought $750. The news of such good finds spreads rapidly throughout the locality and is a great stimulus to the pearl and shell industry. The pearlers become expert in their line of business and can usually tell at a glance from what general class of shells the pearls and slugs are taken. For example, it is well known to them that the lower river beds produce "washboard stuff," which is very white, although some of the pieces may be stained similar to the spots in the shell, and the upper river stretches yield a large quantity of "blue-point stuff," often having a tinge of pinkish color.

TABLE 9.—DISTRIBUTION OF MUSSELS AT THE PRINCIPAL STATIONS ALONG THE ILLINOIS RIVER.

Mussel species.	Henry.	Chillicothe.	Peoria Lake.	Pekin.	Havana.	Bath.	Beardstown.	La Grange Locks.	Meredosia.	Naples.	Valley City.	Florence.	Bedford.	Pearl.	Spar Island.	Kampsville.	Diamond Island.	Hardin.	Twelve-mile Island.	Six-mile Island.	Grafton.	Spoon River.	Sangamon River.
1. Purple warty-back (*Quadrula granifera*)	..	×	×	..	×	×	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
2. Purple warty-back (*Quadrula tuberculata*)	..	..	..	..	..	..	..	×	..	..	..	..	..	..	..	..	×	×	..	..	..	..	..
3. Niggerhead (*Quadrula ebena*)	..	×	×	×	×	×	×	×	×	×	×	×	×	×	..	×	×	×	×	×	×	..	×
4. Niggerhead (*Quadrula pyramidata*)	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	×	×	..	..	..	..
5. Niggerhead (*Quadrula plena*)	..	..	..	×	..	..	..	..	..	..	..	..	..	..	..	..	..	×	..	..	..	..	..
6. Niggerhead (*Quadrula solida*)	..	..	..	×	..	..	×	×	..	×	..	×	×	..	×	..	×	×	..	..	..	..	..
7. Tuin niggerhead (*Quadrula coccinea*)	..	..	..	×	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
8. Ohio River pig-toe (*Quadrula obliqua*)	..	..	..	×	..	..	×	×	×	×	..	×	×	..	..	×	×	×	×	..	..	×	..
9. Pig-toe (*Quadrula trigona*)	×	×	×	×	×	×	×	×	×	×	×	×	×	×	..	×	×	×	×	×	×	×	×
10. Wabash pig-toe (*Quadrula rubiginosa*)	..	..	..	×	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
11. Two-horned pocketbook (*Quadrula pustulata*)	..	..	..	..	..	×	×	×	×	..	..	×	×	..	..	×	×	×	×	..	×	..	..
12. Warty-back (*Quadrula pustulosa*)	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×
13. Maple-leaf (*Quadrula fragosa*)	..	..	..	×	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
14. Maple-leaf, stranger (*Quadrula lachrymosa*)	×	×	×	×	×	×	×	×	×	×	×	×	×	×	..	×	×	×	×	×	×	×	×
15. Monkey-face (*Quadrula metanevra*)	..	..	..	×	..	..	×	..	×	..	..	..	×	..	..	..	..	..	..	..	..	×	..
16. Washboard (*Quadrula heros*)	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	..
17. Blue-point (*Quadrula undulata*)	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×
18. Three-ridge (*Quadrula plicata*)	×	×	×	×	×	×	×	×	×	..	..	×	..	×	×	..	×	×	×	×	×	×	..
19. Bullhead (*Pleurobema æsopus*)	..	..	..	..	..	×	..	..	×	..	..	..	..	..	..	..	..	..	..	..	..	..	..
20. Elephant ear (*Unio crassidens*)	..	×	..	..	..	×	..	..	×	..	..	×	..	×	..	×	×	×	×	..	×	..	..
21. Lady-finger, spike (*Unio gibbosus*)	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	..
22. Spectacle-case (*Margaritana monodonta*)	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	×	..	..	..	..	..	..
23. Whitehatchet-back (*Symphynota complanata*)	×	..	×	..	×	×	×	×	×	×	..	..	..	..	..	..	..	..	..	..	..	..	..
24. Fluted shell (*Symphynota costata*)	..	..	..	..	..	×	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
25. Rock-shell, queen (*Arcidens confragosus*)	×	×	×	..	×	×	×	×	×	×	×	×	×	×	..	×	×	×	×	×	×	..	..
26. Rock-shell, queen (*Anodonta corpulenta*)	..	..	×	..	×	×	..	..	..	..	..	..	..	..	..	..	..	×	..	..	..	..	..
27. Floater (*Anodonta grandis*)	×	..	..	..	×	×	..	×	..	..	..	..	×	×	×	..	×	×	×	..	..	..	..
28. Floater (*Anodonta suborbiculata*)	..	..	×	..	×	×	..	..	..	..	..	..	×	..	..	..	..	..	..	..	..	..	..
29. Floater (*Anodonta imbecillis*)	..	..	×	..	×	×	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
30. Squaw-foot (*Strophitus edentulus*)	..	..	×	×	..	×	..	..	..	..	..	×	..	..	..	..	..	×	..	..	..	..	..
31. Three-horned shell (*Obliquaria reflexa*)	..	×	×	..	×	×	×	×	..	×	×	..	×	..	×	×	×	×	×	×	..	..	..
32. Pistol-grip, buckhorn (*Tritogonia tuberculata*)	×	..	×	..	×	×	×	×	×	..	×	..	×	×	×	×	×	..	..	×	×	×	×
33. Pistol-grip, buckhorn (*Plagiola donaciformis*)	..	..	×	..	×	×	×	×	×	..	..	×	×	..	..	×	×	..	..	..	..	..	..
34. Deer-toe (*Plagiola elegans*)	×	..	×	..	×	×	×	×	×	×	×	×	×	..	×	×	×	×	×	×	×	×	..
35. Butterfly (*Plagiola securis*)	..	×	×	×	×	×	×	×	×	×	×	×	..	×	×	×	×	×	×	..	..	..	..
36. Missouri niggerhead (*Obovaria ellipsis*)	..	..	×	..	..	..	..	..	..	..	..	×	×	..	..	×	..	×	×	..	×	..	..
37. Paper-shell (*Lampsilis lævissima*)	..	..	×	..	×	×	×	..	×	..	..	×	..	×	..	..	..	×	×	..	..	..	..
38. Paper-shell (*Lampsilis gracilis*)	×	×	×	×	×	×	×	×	..	×	..	×	..	×	×	×	×	×	..	×	..	..	..
39. Pink hatchet-back (*Lampsilis alata*)	×	..	×	×	×	×	×	×	..	..	..	×	×	×	×	×	..	×	..	×	..	×	×
40. Pink hatchet-back (*Lampsilis parva*)	..	..	×	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
41. Black sand-shell (*Lampsilis recta*)	..	×	×	..	×	×	×	×	×	×	×	..	..	×	..	×	×	×	×	×	×	×	×
42. Slough sand-shell (*Lampsilis fallaciosa*)	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	..	×
43. Yellow sand-shell (*Lampsilis anodontoides*)	..	..	×	..	×	×	×	×	×	..	×	×	..	×	×	×	×	×	×	×	..	..	..
44. Higgins-eye (*Lampsilis higginsii*)	..	×	×	..	×	×	×	..	×	..	..	×	..	×	..	×	..	×	×	..	..	..	..
45. Higgins-eye (*Lampsilis orbiculata*)	..	×	×	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
46. Mucket (*Lampsilis ligamentina*)	×	×	×	×	×	×	×	×	..	×	×	×	×	×	×	×	×	×	×	×	×	×	×
47. Fat mucket (*Lampsilis luteola*)	×	×	×	×	×	×	×	..	×	..	..	×	..	×	×	..	..	×	..	..	..	..	..
48. Pocketbook (*Lampsilis capax*)	..	..	..	×	×	×	×	..	..	..	×	×	..	×	..	×	..	×	×	..	×	..	×
49. Pocketbook (*Lampsilis ventricosa*)	..	..	×	..	×	×	×	×	×	×	×	×	..	×	..	×	×	×	×	×	×	×	×

MUSSEL SPECIES.

There have been recorded about 63 species of Unionidæ from the Illinois River and its principal tributaries.[a] During the present investigation, however, the following 49 species were found in the main stream. About 20 of these are suitable for manufacturing purposes, although only 6 or 7 occur in sufficient quantities to be of practical worth.

[a] Baker, Frank Collins: A catalogue of the Mollusca of Illinois. Bulletin of the Illinois State Laboratory of Natural History, vol. VII, art. VI, September, 1906.

1. Purple Warty-back, *Quadrula granifera* (Lea). -This is a rather rare shell in the Illinois, although a few examples were found in the upper half of the shell-producing portion of the river at Chillicothe, Peoria, Havana, and Bath. It is an inflated shell, heavy anteriorly, and reaches a good size, but on account of its dull purple nacre it is not now used for the manufacture of buttons. After the cooking-out process, this shell is discarded by the mussel fishermen as worthless. The purple warty-backs, paper-shells, lady-fingers, and other culls are gathered along with the commercial species, and although they are known to be of no particular value, they are saved for the meats for fish bait, and also because they occasionally produce good pearls.

2. Purple Warty-back, *Quadrula tuberculata* (Rafinesque).—Rare; some examples of this mussel were found in the lower stretches of the river where the water is swifter, as below the Government locks at La Grange, at Diamond Island, and at Hardin. There appears to be a more or less gradual change from the inflated *granifera* of the upper stretches, where there is but little current and the bottom is composed largely of soft mud, to the much flatter *tuberculata* of the lower river where the bottom is harder and the current is stronger. This shell, like the *granifera*, has a dull purple nacre, and at the present time has no commercial value.

3. Niggerhead, *Quadrula ebena* (Lea).—On account of its good size, firm texture, and fine pearly luster this is the most valuable button shell of the United States. Near the tips it produces a few iridescent buttons. Although widely distributed throughout the entire river, this species is so rare in the upper stretches that often only one or two examples are found in a ton of shells. In the lower third of the river the conditions are better; the number may run as high as 2 or 3 per cent. It has been stated that eight or nine years ago the *ebena* and *ligamentina* (mucket) were fairly abundant in many beds of the Illinois, though the indications are that the former was never very plentiful.

Some mussel fishermen are of the opinion that the annual deposit of sediment, covering up the beds, is one reason for their diminution. Mr. J. F. Mayes, of Meredosia, Ill., has tried an experiment along this line, and states that if a washboard (*heros*), niggerhead (*ebena*), and a mucket (*ligamentina*) are put into a bucket and water and sand are added only the washboard will reach the surface; the others will be suffocated. This may explain the situation for some beds where the silting occurs rapidly at a time when the animals are more or less dormant, but does not appear satisfactory for the entire river.

Some examples of *ebena* taken at Peoria and Florence have the umbones wide apart, and are similar to Call's figures of this species,

as illustrated in his paper on Mollusca, in the Indiana Geological Report, for 1899.

This species was found gravid, early embryo, all four gills, July 12.

4. *Quadrula pyramidata* (Lea).—Rare; a few samples were found in the last stretch of the river at Hardin and at Twelvemile Island. This shell is very heavy anteriorly and thin at the tips. Some examples have pink nacre. This and the two species following are usually classed with and generally called "pig-toes" by the mussel fishermen.

5. *Quadrula plena* (Lea). -Rare; an example or two were found at Peoria and Hardin.

6. *Quadrula solida* (Lea).—A comparatively rare species, although found in several mussel beds from Peoria to Hardin, more particularly at Peoria, Beardstown, Meredosia, and Valley City. The nacre varies from white to salmon. This shell furnishes good button material.

7. Thin Niggerhead, *Quadrula coccinea* (Conrad).—This is a very rare species in the Illinois. Some examples were found in Peoria Lake.

8. Ohio River Pig-toe, *Quadrula obliqua* (Lamarck).—This shell, while not a common one in the Illinois, is found generally distributed throughout the river. It furnishes good button material, but is hardly equal in size or quality to the species in the Ohio River beds.

9. Pig-toe, *Quadrula undata*[a] (Barnes).—Although this species in the Illinois is the most abundant of the "pig-toe" group, it forms but a small percentage of the mussel output. Some beds, depending upon the parts worked, gave the following percentages: Chillicothe, 7; Pekin, 3; Florence, 9; and Hardin, 2.

This is a good button shell, but has considerable waste on account of the heavy umbones. At Peoria small *undatas* just large enough to make one blank were taken and sold by some of the mussel fishermen. As an excuse for these small shells in their piles they said, "The pig-toes are running smaller now."

Some examples had orange flesh. Found gravid in all four gills June 20.

10. Wabash Pig-toe, *Quadrula rubiginosa* (Lea.).—This is a rare species in the Illinois. The only examples found were taken from Peoria Lake.

11. Two-horned Pocketbook, *Quadrula pustulata* (Lea).—Although this mussel is generally distributed throughout the river, it is found in very small numbers. It is usually classed with the *pustulosa*, or warty-backs, but is hardly as good material for manufacturing purposes.

[a] According to Mr. Bryant Walker, Nautilus, vol. xxiv, p. 6, the name *undata* has precedence over the one (*trigona*, Lea) commonly used.

12. Warty-back, *Quadrula pustulosa* (Lea). The *pustulosa*, or warty-back, is a very common shell in the Illinois, certain very productive beds yielding a large per cent of the output. This mussel, though thin at the tips and in old specimens heavy at the beaks, is of good size, quality, and luster and often classed next to the niggerhead for manufacturing purposes. There are a number of variable forms of this species among our examples, one of which (no. F 6245), found at Henry, Ill., June 19, was referred to Mr. Bryant Walker, who states that it "is a young and very much inflated *dorfeuilleanus*, which Simpson calls a synonym of *pustulosa*. I think it quite likely that some day it may be given varietal rank." This mussel often contains a number of slugs; one of our examples had nearly 50 small nacreous pieces at the dorsal part of the body. Found gravid July 5.

13. Maple-leaf, *Quadrula fragosa* (Conrad).—Rare; an example was found in Peoria Lake, but it does not agree exactly with *fragosa* as we found it in the Cumberland River, near Clarksville, Tenn.

14. Maple-leaf, *Quadrula lachrymosa* (Lea). *Lachrymosa*, while not common, occurs in small numbers in practically all the mussel beds of the river. Some examples of this shell found with projecting tubercules, appear to be the form described as *asperrima*, now a synonym. This shell has good luster and size in the Illinois and is usually classed as first-grade material. One example found in the Spoon River measured 4½ inches in length.

15. Monkey-face, *Quadrula metanevra* (Rafinesque).—A rare species in the Illinois, but few specimens being found at the stations given in the general table on page 37.

The green triangular markings so prominent in well-defined species are faint in our specimens. Some examples vary considerably in shape and general appearance. One is heavily pustulose anteriorly, many of the pustules being elongate along the lines of growth, and is strongly suggestive of *Q. pustulosa*. Another of our examples has the markedly pinched posterior dorsal portion generally pronounced in this species in the lower Wabash. All of our shells are noticeably inflated.

16. Washboard, *Quadrula heros* (Say). *Heros* is the best button shell of the Illinois and produces the most blanks per ton, but in some localities is porous and does not do well for an engraved button. The three-ridge type makes a better finished button. In the upper stretches of the river the complete washboard shell averages about 1 pound in weight and is frequently spotted; but from below Beardstown to Twelvemile Island it is much smaller, flatter, freer from spots and stains, and of good luster. At Hardin this shell is no larger than the *undulata* or bluepoint of Peoria Lake, even old examples called "bald-pates" found in the channel are small.

In some localities, as at Quiver Lake, above Havana, the old *heros* are dead; not a single living example was taken, excepting the young, indicating that whatever the cause of the mortality had been, more favorable conditions exist at present.

Small shells 2 or 3 inches long are taken by the mussel fishermen; and while they make a few good blanks, to take them is very wasteful, as they should be thrown back into the river and allowed to mature.

In our collection there are three examples of this shell, which show very clearly the abnormal ridge and valley caused by the growth of pearls within. Two of the shells were found near Bath, Ill., and the other at Peoria.

Plate. II represents a *heros* or washboard, measuring $4\frac{5}{8}$ by $6\frac{1}{2}$ inches. The nacre is remarkably clear. From the entire shell, 5 dozen 24-line blanks were cut at the button factory of Mr. J. H. Carner, Beardstown, Ill.

17. Blue-point, *Quadrula undulata* (Barnes).—The *undulata* is a very abundant species and is regarded by the button men as a very desirable shell. It is rather flattish, particularly at Chillicothe, though lower down the river it is somewhat more inflated. It is rather thin and light in weight but of good size and luster.

The shell is commonly called the blue-point, but in some camps the name of "purple-tip" is applied to it on account of the slight purple tinge at the posterior end.

A few examples almost free from ridges were found in Peoria Lake and at Florence, Ill. Prof. Richardson, of the State biological station at Havana, had two similar specimens taken from the river at that place.

This mussel was found spawning July 12.

18. Three-ridge, *Quadrula plicata* (Say).—The three-ridge is much less abundant and not so valuable a shell as the blue-point. Being usually more inflated, heavier at the beaks, and with larger ridges, it leaves more waste after the blanks are cut.

At Meredosia, it is claimed that the *plicata* has a tendency to crumble when cut. Found gravid July 8 and 15.

19. Bullhead, *Pleurobema æsopus* (Green).—Rare; examples were found only at Bath and Meredosia. It is brittle and not a good button shell; moreover, being so uncommon in the Illinois, it is disregarded altogether.

20. Elephant-ear, *Unio crassidens* (Lea).—Rare; although found in most of the beds, the percentage is so small that it is practically a negligible quantity. The nacre varies from pink to white. This shell is used for making novelties.

21. Lady-finger, Spike, *Unio gibbosus* (Barnes).—The lady-finger is not now a commercial shell unless it be white, which is seldom the

case. It is found in large quantities along the river, some beds, which the clammers avoid as much as possible, having a very large percentage. Above the upper bridge at Peoria there are two small beds of this species; one bed consists mostly of white nacred shells, while in the other the nacre is the ordinary dull purple color. At Meredosia a driveway leading from the river to the bank above is covered with about 60 tons of these shells. They had been purchased at a low price in the hope that there would be a demand for them. Button cutters claim that even the white *gibbosus* do not make good blanks on account of the shell being brittle.

In the Cumberland River, *crassidens* is much more abundant than *gibbosus*, which is the poposite condition in the Illinois.

22. Spectacle-case, *Margaritana monodonta* (Say).—Rare; only one example was found during the entire trip, at Diamond Island, above Hardin, although there were some specimens from this river at the biological laboratory at Havana, Ill. The shell is too thin and brittle to be of any commercial importance. Not so large as the Cumberland River species.

23. White heel-splitter, *Symphynota complanata* (Barnes).—When of sufficient thickness, this shell is used for buttons. It is fairly common in the Illinois, and from its flat shape and outline is often called the "elephant-ear" by the mussel fishermen. It is found in sloughs and in mud bottoms.

24. Fluted-shell, *Symphynota costata* (Rafinesque).—Rare; only one example found, at Bath.

25. Rock-shell, Bastard, Queen, *Arcidens confragosus* (Say).—Found in small quantities on almost all of the mussel beds. It is not regarded as particularly good button material. This shell is sometimes called the black pocketbook, rock pocketbook, and bastard. An extra large and inflated example was found at Havana, June 28.

In young examples of *confragosus* the interior surface of the shell is indented or pitted to conform with the more pronounced pustules on the outside. This condition at the end of probably two years disappears, the shell becoming covered with subsequent layers of nacre.

26. *Anodonta corpulenta* (Cooper).—Four *Anodontas*, the *corpulenta*, *grandis*, *suborbiculata*, and *imbecillis*, were found during the present survey. They are thin, paperlike shells and have no commercial or economic value, excepting perhaps as they are used occasionally by the mussel fishermen for fish bait or hog feed. The *corpulenta* is found in sloughs, and on soft mud bottoms.

27. Floater, *Anodonta grandis* (Say).—Distributed as the preceding species. Shells which have recently been killed rise to the surface of the water on account of the gases of decomposition and

are seen floating along with the current; hence the common name of "floater." *Grandis* and *corpulenta* are often affected with parasites, particularly at the posterior end. Our examples were all of only moderate size as compared with shells seen in retired places along the Cumberland.

28. *Anodonta suborbiculata* (Say).—*Suborbiculata* is widely distributed and is generally found on mud bottoms and in slack water.

29. *Anodonta imbecillis* (Say).—This small, delicate shell is very abundantly distributed, especially in the more retired places of quiet waters. Found gravid June 27 and July 2.

30. Squaw-foot, *Strophitus edentulus* (Say). Found rather scattering throughout the various stretches and mussel beds of the river. The nacre is usually of a yellowish color. This shell has no particular commercial value, although some examples are found which are of sufficient thickness and size for manufacturing purposes.

31. Three-horned Shell, *Obliquaria reflexa* (Rafinesque).—This mussel is widely distributed and is usually of small size. There are two or three forms of *reflexa* found in the Illinois. In the upper stretches of the river it is of the ordinary shape and size found in other streams, and although it can be used for manufacturing purposes it is not a particularly valuable shell to propagate. In the Peoria Lake region, however, where the current is slow and the bottom is composed of soft mud, the shell is often very heavy and rounded anteriorly, while posteriorly it is thin and much elongated, which no doubt is the result of accommodation to natural conditions. In the lower stretches the shell, though heavy and inflated, is considerably smaller than those in the upper portions of the river. A number of our examples have five tubercules on each valve. Found gravid June 27 and July 3.

32. Buckhorn, Pistol-grip, *Tritogonia tuberculata* (Barnes).—Although this interesting species is comparatively rare in the Illinois, it is widely distributed. The name of pistol-grip is applied to it in some localities, owing to the fact that it fits the hand like a pistol. The characteristic ridge of this shell gives it somewhat the appearance of the abnormal ridge found occasionally on the *heros* or washboard as the result of pearl growth. While this shell has a ridge on each valve, the abnormal washboard has but one valve ridged, the other having a corresponding valley.

The buckhorn furnishes good material for the manufacture of buttons and novelties.

33. Little Pocketbook, *Plagiola donaciformis* (Lea).—This small mussel, although of no commercial value, is very common in the Illinois. There are two types of this species found in many beds, differing in shape to a certain extent and particularly in color. On

account of its resemblance to *L. ventricosa* it is often called the "little pocketbook." Found gravid June 27 and July 4.

34. Deer-toe, *Plagiola elegans* (Lea).—This beautiful species is found in small quantities throughout the entire river. It is hardly considered a commercial shell, but the larger and thicker examples are often seen in the mussel camps and piles along the shore. The length of the largest shell of this species found during the survey was $2\frac{3}{4}$ inches (70 mm.). Some examples, particularly from those portions of the river having soft mud bottoms, are greatly elongated posteriorly, and others bear a strong resemblance to *P. donaciformis*.

There are two forms of *elegans* found in several of the mussel beds of the Illinois, particularly noticeable at Peoria. The common form is the more abundant and compares favorably with the species in the collection of the Unionidæ at the Bureau of Fisheries and with those found in the Maumee and Wabash Rivers. The other form is proportionately more inflated, and has brownish epidermis, darker posteriorly, with dark capillary lines. The pseudocardinal teeth are heavy and curved; the laterals are broad and striate. The nacre is pink. The truncated shape gives it somewhat the appearance of *Truncilla triquetra* (Rafinesque). Some fine examples were found near the upper bridge, at Peoria, Ill., June 27.

35. Butterfly, *Plagiola securis* (Lea).—The butterfly, or *securis*, is not a common species in this river, although many of the beds could be made to yield productively by propagation. On account of its flatter shape and proportionally lighter weight, the male shell is more valuable for commercial purposes than the female.

36. Missouri niggerhead, *Obovaria ellipsis* (Lea).— This species is comparatively rare in the Illinois Valley, but some examples were found from Peoria Lake to the mouth. This shell has a velvety epidermis and a good pearly nacre and furnishes good button material. The *ellipsis* appears to be closely related to *higginsii*.

37. Paper-shell, *Lampsilis lævissima* (Lea). -This shell is fairly common in the river, and at the present time has no economic value. In nearly every example examined at Beardstown and a few other places, this mussel was more or less diseased at or near the tips or posterior end, due to parasitic infection.

38. Paper-shell, *Lampsilis gracilis* (Barnes). This mussel resembles the preceding species. The shell is thin and has no commercial value, though the meats or soft parts are used occasionally for fish bait. Found gravid June 27.

39. Pink Heel-splitter, *Lampsilis alata* (Say).—This species is fairly common and is found mostly on mud bottoms. It has no commercial value. One of our examples, taken at Hardin, is thick enough for manufacturing purposes and has a good white nacre.

40. *Lampsilis parva* (Barnes).—A rare species; one example found in Peoria Lake. This is a small, delicate shell of no economic value.

41. Black Sand-shell, *Lampsilis recta* (Lamarck).—The black sand-shell is a rather common one and reaches a very large size in this river. It is found in the lakelike places of the stream and in the swifter parts of the lower stretches. The nacre is generally pinkish or purple and, although the texture is good, the shells are discarded by the mussel fishermen and buyers, as there appears to be no particular demand at the present time for colored shells. The white-nacred ones, though much less abundant, are always saved. They are usually classed along with the yellow sand-shell, and are mad use of in novelty factories. In the mussel camps this shell is often called "lady's slipper," on account of the appearance of the valves when opened out flat.

42. Slough Sand-shell, *Lampsilis fallaciosa* (Smith).—Abundant; usually found standing on end burrowed in the mud of sloughs and bays or along the shore where there is but little current. When of sufficient size and thickness, they are classed with the yellow sand-shell. In Peoria Lake the *fallaciosa* are beautifully rayed.

Some doubt has arisen as to whether this species is identical with *anodontoides*, but it appears on the Illinois to be a distinct species. Our examples are markedly different from *anodontoides* of the same region. The *fallaciosa* vary greatly in distinctness and abundance of rays, some being but faintly rayed, others with many broad pronounced green rays. One example, a fine large male, is so heavily rayed as to be almost green, and approaches more nearly than any of the others the general form of *anodontoides*, but could not well be confused with that species. A well-rayed female of moderate size is noteworthy for a marked reddish-orange cast of the epidermis, the shell beneath having a rosy tinge. Another constant difference in our examples is the cardinal tooth of the right valve, which is compressed and almost lamelliform in *fallaciosa*, while in *anodontoides* it is more triangular.

It is quite possible that the convergence of the two species in the southern and southwestern portions of the United States is due to the different features of bottom and general abundance of silt and slough-like conditions in the lower courses of rivers, which would cause all to assume the characters of the slough-dwelling form.

43. Yellow Sand-shell, *Lampsilis anodontoides* (Lea).—This species is found sparingly throughout the upper river, but is fairly abundant in the Hardin district, where it is in sufficient quantity to be sorted out and sold separately at an advanced price. This shell is the most valuable of the fresh-water mussels, and as it is easily propagated, many of the beds where the conditions are favorable could be restored. It prefers deep water and clean sandy bottoms.

Our examples have a rich yellow epidermis, and are appropriately called "banana shells" in some localities. This shell is valued at about $60 per ton.

44. Higgins-eye, *Lampsilis higginsii* (Lea).—Not common, though widely distributed, particularly over the lower half of the river. The males sometimes bear a strong resemblance to *Obovaria ellipsis*. There are four females in our collection and they present marked differences and peculiarities: One is normal and requires no comment; another flattened, flaring posteriorly, and suggests permanent sterility; another example has that portion covering the brood pouch strongly inflated, the portion of the shell immediately behind it underdeveloped and a trifle sulcate, forming a slight emargination; the general form suggests overdevelopment. The remaining example somewhat resembles this, but is flatter.

45. *Lampsilis orbiculata* (Hildreth).—This species has good luster and thickness. There are two examples in our collection, one from Chillicothe and the other from Peoria. The nacre of one is rather pinkish. This species is difficult to separate from *higginsii*, but is generally more southern in distribution.

46. Mucket, *Lampsilis ligamentina* (Lamarck).—The mucket occurs in small numbers throughout the entire river but is more plentiful in Peoria Lake than elsewhere. This mussel is usually smaller and thinner than those of the Kankakee, Fox, and Wabash Rivers, but nevertheless is regarded as a first-class commercial shell and is a very desirable species for propagation. Our examples and those seen in the shell piles along the shore have a pearly white nacre, while in some rivers as, for example, the Mississippi—there are found a fair percentage with a pinkish color. The mucket was found gravid, late embryo, July 9.

47. Fat Mucket, *Lampsilis luteola* (Lamarck).—The fat mucket is widely distributed, though like the preceding species it is more plentiful in Peoria Lake. The male shells are much more desirable for button purposes than the female, the latter, especially in the older specimens, being more inflated and more troublesome to cut. This shell is often called the black mucket and pug-nose mucket. Found gravid June 27.

48. Pocketbook, *Lampsilis capax* (Green).—This is a rare species in the Illinois, and was found more frequently below locks and dams where the water was swifter. It is not a desirable shell to propagate.

49. Pocketbook, *Lampsilis ventricosa* (Barnes).—While this species is not a common one, it is more plentiful than the preceding mussel, and, like it, was more abundant in the swifter parts of the river, as below locks and dams. Some beautiful young examples, having a very delicate pink nacre and fine epidermal markings, were

taken, especially at Peoria and Meredosia; this is a remarkable condition for so muddy a river as the Illinois. This pocketbook, though inclined to be brittle, is usually good button material.

SUMMARY AND CONCLUSIONS.

The Illinois river is 273 miles in length, and, from a mussel fisherman's point of view, it is one of the most important tributaries of the upper Mississippi.

Sewage pollution, with perhaps one or two exceptions, does not appear to have decreased the abundance or quality of the shells within the last 180 miles of the river.

The dip net is used almost exclusively in the Peoria Lake district and a few other places where similar lakelike conditions exist.

The price per ton of the river run of commercial shells during 1912 was $12 to $13.

Some excellent pearls have been found, ranging in value from a few dollars to $2,700. Slugs do not average more than one-half ounce per ton of shells.

The laws relating to mussel fishery have been generally observed.

There are 15 button or blank factories, with about 250 machines, along the river. The raw material is being better utilized than formerly.

The abundance of dead shells on many of the mussel beds may be due in part to the lack of erosion of the water and to the injurious effects of the crowfoot hooks.

The levees which have been heretofore and are now being constructed, particularly in the lower stretches of the river, reduce to a large extent the breeding grounds of the valuable species of fishes and incidentally affect the future supply of the mussels. During their early life mussels are parasites upon fishes for a period of from two to six weeks, and if the fish supply is greatly reduced it is readily seen that the mussel supply will also be materially reduced.

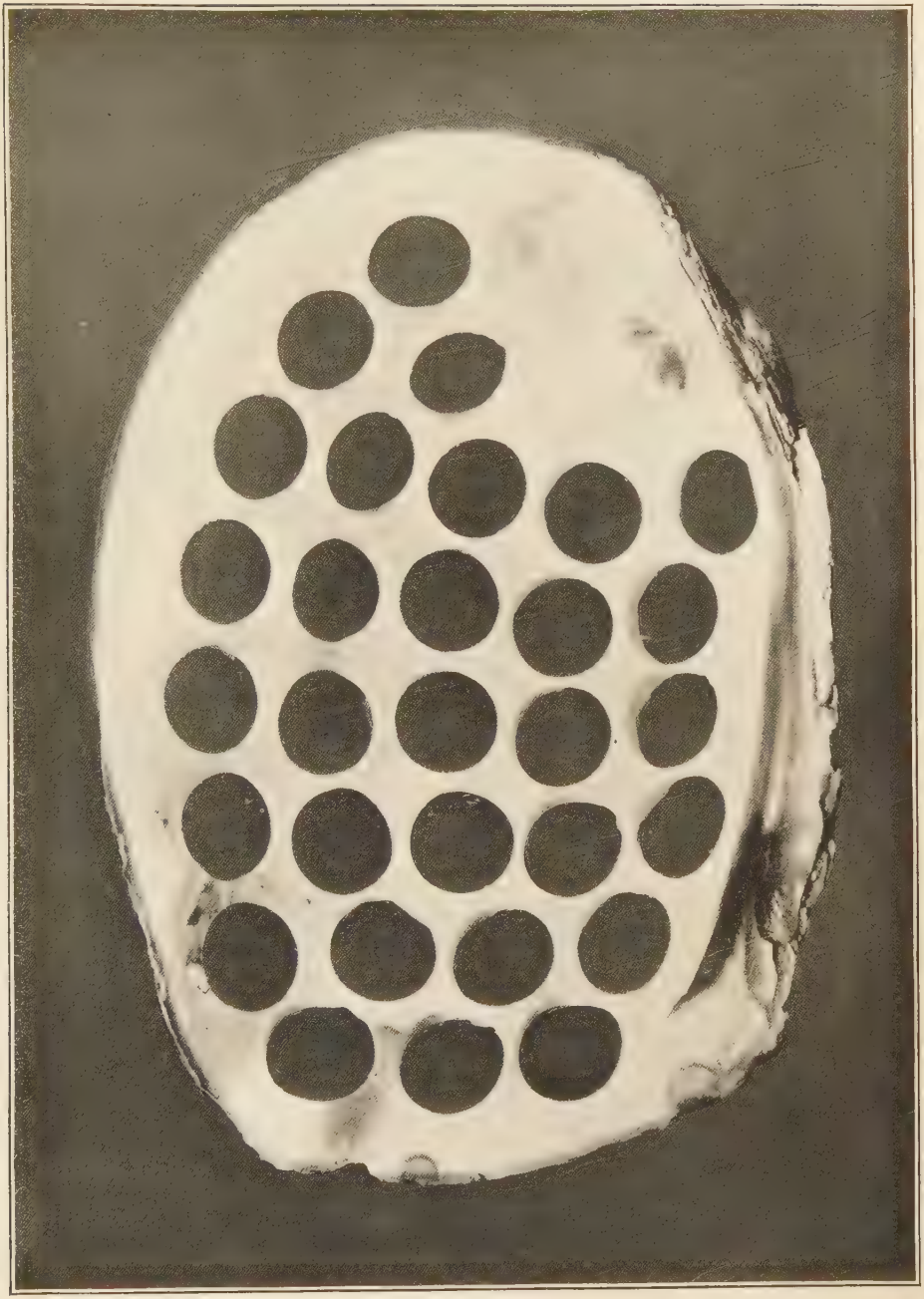
The washboard, or blue-point (*Quadrula*), group of mussels predominates in the Illinois. The slow current, mud bottoms, good average depth of water, and large fish resources all tend to make the river an ideal one for this group. The niggerheads (*ebena*), although apparently never very abundant, have become greatly reduced in numbers, from a cause not definitely determined. The old washboards (*heros*) in some places, as at Quiver Lake above Havana, have been killed, though the present conditions there appear to be more favorable.

The mucket (*Lampsilis*) group is found scattered in small quantities throughout the entire river, but more abundantly in Peoria Lake and the lower stretches.

The Illinois has been the most productive stream per mile of any in the country. There are but few places within the limits of shell production that do not support mussel beds, though certain stretches, as between Peoria and Kampsville, show marks of depletion.

The immediate future of the Illinois is good, but unless suitable mussel propagation is introduced and carried on under proper management, the river will become depleted within a few years and a valuable source of revenue thus be lost to the State.

There are several good localities where the propagation of mussels could be carried on successfully, as at Peoria, Havana, Bath, Beardstown, Meredosia, Pearl, Kampsville, and Hardin.



WASHBOARD (QUADRULA HEROS), SIZE 4⅞ BY 6½ INCHES.

Five dozen buttons were cut from the entire shell.

AN EITHER OR VIEW OF A WASHBOARD QUADRULA HEROS SHOWING THE ABNORMAL RIDGE ON THE RIGHT VALVE AND THE HOLLOW ON THE LEFT VALVE WHICH ARE SIGNS OF THE PRESENCE OF A PEARL BUTTON

AN INTERIOR VIEW OF THE SHELL REPRESENTED IN PLATE III.

It shows the reverse condition of the ridge and valley, and also the position of the pearl, which weighed 11 grains. The nacre of the shell, at the point where the pearl was found, is clear. A shell very similar to this one was found in the right chute of Grand Island, and contained a 10-grain high-button pearl, but was stained and contained mud. The shell was also stained at the point where the pearl was found.

FIG. 1.—A THREE-RIDGE (QUADRULA PLICATA) WHICH WAS INJURED AND CONTAINED NO PEARLS.

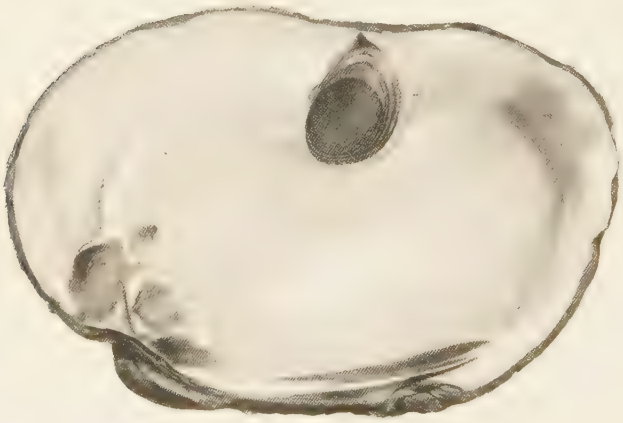
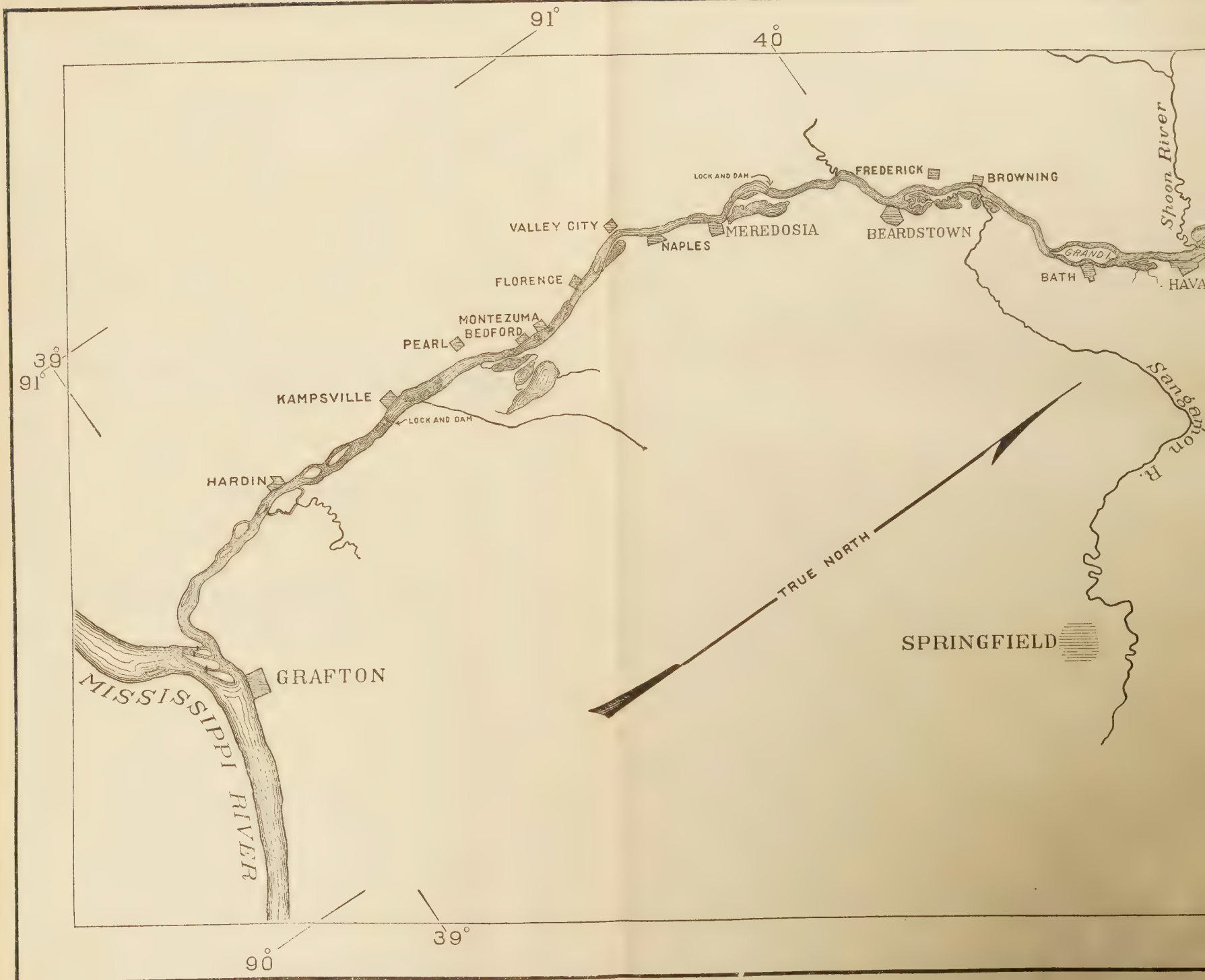
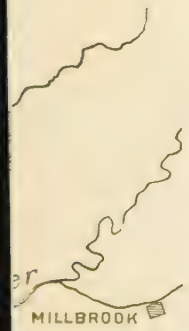
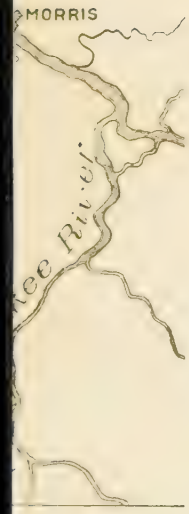


FIG. 2.—ONE VALVE OF A THREE-RIDGE (Q. PLICATA), SHOWING THE CAVITY FROM WHICH AN EMBEDDED 58-GRAIN TURTLEBACK PEARL WAS TAKEN, WHICH WHEN PEELED PRODUCED A FINE 20-GRAIN HIGH-BUTTON.

This shell, on account of the distortion caused by the pearly growth, is somewhat kidney-shaped.


91°
40°
LOCK AND DAM
FREDERICK
BROWNING
Spoon River
VALLEY CITY
NAPLES
MEREDOSIA
BEARDSTOWN
GRAND I.
BATH
HAVA
FLORENCE
MONTEZUMA
BEDFORD
PEARL
39°
91°
KAMPSVILLE
LOCK AND DAM
Sangamon R.
HARDIN
TRUE NORTH
SPRINGFIELD
GRAFTON
MISSISSIPPI RIVER
90°
39°


MILLBROOK


MORRIS

THE MUSSEL FISHERY OF THE FOX RIVER

By John A. Eldridge

Appendix VII to the Report of the U. S. Commissioner
of Fisheries for 1913

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THE MUSSEL FISHERY OF THE FOX RIVER.

By JOHN A. ELDRIDGE.

The portion of the river embraced by the inquiry and dealt with in this report is that between Pistakee Bay, just south of the Wisconsin State line, and the mouth of the river at Ottawa, Ill., a distance of about 90 miles. The conditions of the stream were ascertained in part from observation and experiment, in part from questioning shellers, buyers, and manufacturers. The time of the inquiry proved unfortunate, as cold weather had stopped much of the work carried on during the summer. The brief time devoted to the inquiry prohibited as thorough an examination as was desired.

GENERAL CHARACTERISTICS OF FOX RIVER.

This river, which is about 150 miles in length, rises in Waukesha County, Wis., a little northwest of Milwaukee. It flows south and southwest and enters the Illinois River at Ottawa. (See map, plate VI, preceding paper.)

As described by Forbes and Richardson in their pamphlet on the fishes of Illinois,[a] the drainage basin of the river is an undulating prairie region with more or less woodland and some swamps. For a distance of nearly 75 miles from its source the fall amounts to only a few inches to the mile. In its passage through Kane and Kendall Counties the fall per mile is about 3 feet, but in La Salle County it increases to about 5 feet per mile, making a descent of nearly 125 feet in the lower 25 miles of its course. Its channel even in its lower 75 miles has a breadth of only one-eighth of a mile.

Above Algonquin the river valley forms one of Chicago's foremost summer resorts; throughout this whole region its banks are lined with summer cottages. Its lower course is through fertile farming country, and several flourishing manufacturing cities lie on its banks. Many power dams have been constructed, which, with their influence on the depth, current, and character of the bottom, strongly affect the Mollusca above them. In most places the water is clear and apparently pure, but of late years the refuse of such places as Aurora

[a] Forbes, S. A., and Richardson, R. E.: The fishes of Illinois. Natural History Survey of Illinois, vol. III, p. XLIV–V, 1908.

and Elgin has contaminated it for considerable distances below those cities. This, however, does not seem to have harmed the mussels in these regions.

PEARLS AND SHELLING ON THE FOX.

Pearls have been hunted on the Fox, as upon other mussel-bearing streams, for many years. During the last six years pearl hunting has increased in extent, but did not assume commercial importance until 1909, when hundreds of shellers were at work, chiefly between Millington and Sheridan. Several good finds were made which attracted others to the river, and by the middle of the summer the whole region from Yorkville to Serena swarmed with pearl hunters.

Certain portions of the river have received much notoriety from the newspapers on account of the pearl finds. These stories are often exaggerated, but, even at the prices named, the value of the finds seldom warrants the space given to them. This attention from the press has given the region near Elgin a reputation for pearl production which it does not deserve. The Fox has produced some extremely good pearls; its yield is much above the average; but most of the better finds have been made in the lower river in the neighborhood of Sheridan. From information gained from shellers and pearlers it is estimated that the average value of a season's pearl find for a constant sheller, between Geneva and Yorkville, would not exceed $100. On the mussel bed between Millington and Sheridan, however, extraordinary conditions seem to exist. The average value for finds here has been very high. Many extremely good pearls have been found in the last few years, ranging in price from $1,000 to $1,850. This region seems to have been one of the most fertile pearl producers in the country, though few valuable pieces were found in 1911. A few shellers still continue to work on this bed in spite of the extreme scarcity of shells, depending for compensation almost entirely upon "finds." Shells found in this district are opened by the knife to avoid injuring the pearls by cooking.

The shells in this locality are almost entirely muckets (*Lampsilis ligamentina*); the river bed is rock and gravel and the current is strong.

In 1909 shells were sold for the first time. The beds above Yorkville were tapped the following year and shellers were attracted to the work throughout the entire region between Cary and Sheridan. Two years of heavy shelling depleted the beds near the latter place. Further up, especially near Elgin, pearl hunters have increased in numbers, but the scarcity of shells and other conditions closed the season early. Apparently, shelling here as elsewhere along the river has seen its best days.

CHARACTERISTICS OF THE SHELLERS.

The shellers and pearlers on the Fox are of a totally different type from those found on some of the larger streams. Although the river has been extensively worked for several years and its pearl finds have received much attention from newspapers, few outside shellers have come in. In some cases shellers from other States have been driven out by threatened prosecution under the State mussel law, which requires a license for nonresidents. As a consequence the nomadic class, found so frequently on some rivers, does not exist on this. Most of the shellers here are persons from the factory or the farm, who take an outing of perhaps several days or a few weeks every summer and try their luck on the river. With few exceptions, they are an intelligent, industrious, pleasant class of people.

The pearlers care little for the value of the shells and usually do not save them; they are left on the bank or thrown into the river to litter up the bed and thus are wasted. In some instances the shells are saved by regular shellers who gather them up along the bank or buy them from the pearlers at 5 to 10 cents a bucket, a rate of from $3 to $7 a ton.

The regular shellers who work day after day during the summer months depend chiefly on the shells for a living, and consider any pearls found as so much additional profit. Money from pearls may amount to more than from shells, but this can not be depended upon, for often nothing of value is found during the season and the general average for the year is not very high.

The number of regular shellers on the river during September, 1911, was about 70; in midseason there were probably as many as 100. The number of amateur pearlers on the river on some Sundays in the summer ranges perhaps between 400 and 500.

Many of the regular shellers begin work early in the spring and continue until the season closes October 1. During the season a sheller often gathers as many as 15 or 20 tons of shells, and the daily wages averages $3, exclusive of pearl finds.

METHODS IN USE.

During the greater part of the season the shells are obtained by wading. The outfit consists simply of a pail or burlap bag to hold the mussels and a knife to open them. The regular sheller usually has a boat into which he throws the mussels and opens them by cooking. The mussel bar and mule are but little used, except in cold weather or high water. Some have a wheel at each end serving as a support from the river bottom. The mule which has given most success is a long and narrow one, about 8 feet long by 15 inches wide. In places where there is but little current a windlass is sometimes built upon the

rear end of the boat carrying 500 feet of rope holding an anchor. The anchor is thrown out at the lower end of a bed, the boat rowed upstream to the extent of the rope, and the bar put into the water. Rewinding the windlass pulls both boat and bar downstream over the bed.

FOX RIVER SHELLS.

The most characteristic mussel of the Fox is the mucket (*Lampsilis ligamentina*), which constitutes 90 per cent of the shells sent to market, and is of high grade, almost equaling the niggerhead as a button shell. Its luster is excellent, and its shape allows practically the whole shell to be made into buttons with very little waste. The muckets from the region between Oswego and Yorkville are considered the best; those lower down the river are thinner, and those above are slightly smaller.

On the upper river the mucket is of no importance. The shells saved here run 10 per cent blue-point (*Quadrula undulata*). They are of poor grade and no market has been found for them. Sixty tons of these shells were lying upon the bank above Cary awaiting a buyer at any price. Where there is little current and a muddy bottom the floater (*Anodonta grandis*) is chiefly found, while the fat mucket (*Lampsilis luteola*), the mucket (*Lampsilis ligamentina*), and the three-ridge (*Quadrula plicata*) or the blue-point (*undulata*) are rare. Going downstream, where a strong current and a rocky bottom are found, the mucket appears and increases in numbers until it forms a large percentage of the catch, the floater (*Anodonta grandis*), the fat mucket (*Lampsilis luteola*), and the blue-point (*Quadrula undulata*) decrease, and below Yorkville all are extremely scarce, the latter being seldom seen.

In places where dams check the current and bring about upstream conditions—still water and mud—the three ridges and other shells of the higher river are found in large numbers, while the muckets are scarce.

The fluted shell (*Symphynota costata*), and the squaw-foot (*Strophitus edentulus*), are found in larger numbers on the upper stream; the elk-toe (*Alasmidonta truncata*) more often on the rock bottom lower down; the lady-finger (*Unio gibbosus*), the Wabash pig-toe (*Quadrula rubiginosa*), the purple warty-back (*Quadrula tuberculata*), the pocketbook (*Lampsilis ventricosa*), and the black sand-shell (*Lampsilis recta*) are found in rather small numbers along all parts of the river. The warty-back (*Quadrula pustulosa*) is extremely rare, but two specimens of this species being seen during the investigation out of thousands of shells along the river. It is stated that it was once common.

While the small number of shells involved in some cases tends to render the figures inexact, the following table showing shells obtained at different points along the stream indicates in general the comparative numbers and distribution of the various species.

ABUNDANCE AND VALUE OF THE SHELLS.

The price of shells paid by local buyers varies from $18 to $21 a ton; in some cases prices direct to factory were as high as $24.

Estimates for the last three years of the shipment of the Fox River shells are as follows: 1909, 10 to 12 carloads; 1910, 25 to 30 carloads; 1911, 22 carloads. The catch for next year is expected to be a bare third of that obtained in 1911. More than half of the shells were taken this year from the bed extending from Five Islands to Elgin; several carloads were caught above Elgin, and the rest on the lower river.

Most of the shells are shipped to Iowa factories, and some are sent to Germany every year. There are two blank factories along the river, one at Yorkville with 16 machines, and one at Samonauk with 10, which form the market for a few carloads each year.

Apparently at one time mussels were scattered quite evenly over the whole Fox River, at any rate as far down as Serena. There is no reason to doubt that shells were as plentiful near Sheridan several years ago as in other parts of the stream. The shelling of recent years, however, has in some places nearly exhausted the mussels, and there is a great difference in those remaining. On the river north of Carpentersville, where little shelling has been done previous to this year, 15 to 20 tons of shells were the usual catch per man in 1911; below Elgin on the Five Islands bed, which has been worked for two years, the catch averaged 10 to 12 tons per man; farther down below Yorkville, 7 tons per man were considered a good yield; on the Millington-Sheridan bed, which is the oldest and hardest worked in the river, but 4 tons a year per man could be caught. It was the general opinion that the shelling for 1911 was 50 per cent less than that of the previous year. The only cause for this is the ravages of man. As far as could be determined, but little loss is caused by animals or by natural conditions.

Distribution of Mussels in Fox River.

Mussel species.	Pistakee Bay.	McHenry.	Cary.	Algonquin.	Two miles below Algonquin.	Elgin.	St. Charles.	Oswego.	Yorkville.	Millbrook.	Sheridan.
Purple warty-back (*Quadrula granifera*)	....	....	....	....	1	....	....	....	....	....	....
Wabash pig-toe (*Quadrula rubignosa*)	....	....	3	15	10	2	....	3	4	2	4
Blue point (*Quadrula undulata*)	2	....	40	15	12	6	16	....	....	4	....
Three-ridge (*Quadrula plicata*)	20	2	....	2	....	....	....	....	....	....	....
Lady-finger, spike (*Unio gibbosus*)	....	39	9	34	13	6	4	....	....	....	....
Elk-toe (*Alasmidonta truncata*)	....	....	....	2	....	2	10	....	....	....	2
Fluted shell (*Symphynota costata*)	....	3	8	2	2	....	....	....	....	....	....
Floater (*Anodonta grandis*)	38	8	14	....	....	....	....	....	....	....	....
Squaw-foot (*Strophitus edentulus*)	....	....	....	....	....	....	....	....	....	2	2
Black sand-shell (*Lampsilis recta*)	....	....	2	....	....	....	....	....	2	....	....
Mucket (*Lampsilis ligamentina*)	....	....	6	25	47	78	68	90	94	90	92
Fat mucket (*Lampsilis luteola*)	40	48	14	5	14	....	2	3	....	2	....
Pocketbook (*Lampsilis ventricosa*)	....	....	4	....	1	6	....	4	....	....	....

CONCLUSION.

The foremost fact concerning Fox River shelling is that the mussels are disappearing. The causes that have brought about this condition will probably continue until the beds are completely exhausted, since the unprofessional basis on which the work is conducted will allow its continuance after it has ceased to be profitable. There is but a small professional class which this exhaustion of mussels can influence seriously. This class for the most part will have left the river next year. Yet there are two blank factories near the Fox depending altogether upon it for raw material. Steps should be taken to preserve the mussel beds here for their own sake and because of their importance to the American button manufacturers. The grade of shell is for the most part very good, and the shells have been found in large numbers. The pearls, which have equaled the best in the country, have nearly disappeared.

The conditions observed in 1911 indicated that the industry on this river was doomed to disappear within a year or two unless preventive measures were taken.

WATER-POWER DEVELOPMENT IN RELATION TO FISHES AND MUSSELS OF THE MISSISSIPPI

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Appendix VIII to the Report of the U. S. Commissioner of Fisheries for 1913

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WATER-POWER DEVELOPMENT IN RELATION TO FISHES AND MUSSELS OF THE MISSISSIPPI.[a]

INTRODUCTION.

Begun in January, 1911, and practically completed in June, 1913, the dam on the Mississippi between Keokuk, Iowa, and Hamilton, Ill., is not only an eminent feat of engineering and of efficient and expeditious construction, but it marks an epoch in man's utilization of the greatest North American river. Two hundred thousand horsepower are made available for commercial uses, 65 miles of water deep enough for unimpeded navigation is provided above the dam, and a single lock of the high lift of 40 feet replaces a navigation canal and chain of three locks formerly necessary for the passage of the Des Moines rapids of the Mississippi, now deeply submerged beneath the waters of Lake Cooper. Substantial public benefits are combined with the execution of such an enterprise.

This unique water-power development will have a great significance for the fisheries of the upper Mississippi, not only in the possible checking of the upstream movement of migratory fishes, but in the large area of lake waters it provides through the submerging of former dry land and the backing up of small tributary creeks. It is important to point out the significant advantage to fish and mussel life of the great additions to the feeding and breeding grounds covered by comparatively still water; it is also necessary to call attention to the probable deleterious effect of the dam as an obstruction to the free movement of fishes from the lower river to the upper, and vice versa. How advantage and disadvantage, as regards fish life, are to balance against each other in the future is not to be foretold. Time and observation alone will show, but it is the purpose of this report to present and to analyze the conditions offered by the dam, and to point out the opportunities and the importance of subsequent observations, as well as to offer certain suggestions for the minimizing of harm and the increase of benefit.

It is hoped, too, that the report may serve the broader purpose of pointing out the complexity of the problems involved in the effect of water-power development upon fisheries and of bringing out, even if inadequately, the opportunities and the fundamental necessity of

[a] The illustrations in thi paper are published by courtesy of the photographer, Mr. Anschutz.

a study, not only of fishways, but also of the migratory habits of fishes. There is no view that power development should be sacrificed to fisheries, but we are shortsighted, indeed, if we do not give thoughtful consideration to minimizing any possible sacrifice to fisheries that such developments may entail and to enhancing such advantages as they may afford. In all the active discussion of water-power problems there is almost a painful absence of reference to the fisheries aspects, notwithstanding that the food produced by the American fresh-water fisheries amounts to upward of 330,000,000 pounds, with a value to the fishermen alone of more than $12,000,000 and a value to the consumers far exceeding this amount.

NEW CONDITIONS AND PROBABLE EFFECT UPON MOVEMENTS OF FISHES.

The writer approaches this inquiry with the conviction that the measure of importance of the fisheries of the Mississippi is not found in the existing state of the fishery.[a] The possibilities of the fisheries of the Mississippi and other great rivers will be realized only in the future, near or remote, when, under the pressure of economic conditions, and with the illumination of a more adequate knowledge of the needs of fish life, fish conservation will be more of an actuality than at present. We will then not only comprehend the essential importance of conditions favorable to the development of fish food and to the natural propagation of fishes, but we will know how to supply the necessary conditions. The further belief may be expressed that the future will show that Lake Cooper, as the large body of repressed water above the Keokuk dam is now known, will prove to be an important factor in supplying such conditions and possibly may rival Lake Pepin of the North by offering so large an acreage, or mileage, of comparatively still water provided with shoals and bays sure to be replete with vegetation, and practically free from the deleterious conditions incident to the excessive rise and fall characteristic of ordinary river conditions.

It is one of the tragedies of fish life, catastrophic in degree at times, that the spawning grounds may be found during spring floods far from the main course of the river, where an untimely recession will leave a generation of young fish isolated in some overflow pond, and marked for destruction unless reclaimed by the agency of Government or State. Such fish destruction is evident, and of common knowledge, but that which occurs when the flood stage comes late and after the fish have found nests in the originally shallow waters of the river banks at low stage, can only be guessed at. Accordingly, the significance of the interpolation in the course of a great river,

[a] The fisheries of the Mississippi River and its tributaries yielded in 1908, as shown by the census report, food products of a value well upward of $2,000,000.

whether by natural or artificial means, of an immense pool, where practically fixed and dependable conditions can be found, is not to be lightly esteemed.

It becomes of greater importance that the possible disadvantages incident to such an interpolation should be eliminated as far as possible. Lake Pepin of the upper Mississippi, a virtual lake of natural origin, is a great natural fish reserve into and out of which fish may proceed at will at either end. Lake Cooper of the middle region of the Mississippi is an artificial lake into and out of which fish may pass unchecked in only one direction.

Any student of fisheries will at first glance make a further comparison of these two expansions of the Mississippi. The body of Lake Pepin has a comparatively straight shore line and in some places is bounded by steep bluffs; there is a relative absence of slues and shallows favorable for aquatic vegetation. Above and below Lake Pepin, however, there are many slues and bayous which offer favorable conditions for the breeding of fishes, and undoubtedly the fish life of the lake is continually replenished from these sources. Lake Cooper, on the other hand, has few bluff shores, and throughout its course, except very near Keokuk, there are many favorable bayous, creeks, and expansions over former agricultural or swampy flats. As regards the proportion of deeper waters preferred by some species of fish, the two lakes might compare more closely, except that the deep water in Lake Cooper is at one end and is less extensive.

The relation of such developments to mussel life may be briefly explained. The very young fresh-water mussels, with rare exception, when first liberated from the incubation pouches of the parent, must become parasitic upon fishes in order to pass through the next stage of their existence. To this end, if the chance offers after liberation, the young mussels, or glochidia, as they are called in this stage, attach themselves to the gills, fins, or scales of a fish. The mussels of economic importance attach themselves almost exclusively to the gills. In attaching or biting on the fish a very slight wound seems to be caused, which begins at once to heal over; but in the process of mending, the glochidium is overgrown and thus inclosed within the tissues of the fish. The mussel is now actually an internal parasite, in which condition it remains for a period of two weeks, more or less. It is thus conveyed wherever the fish goes, until, when the proper stage of development is reached, it frees itself from the host and falls to the bottom; if through a favorable fortune it finds suitable lodgment, it continues its growth to form an adult mussel. Owing to this fact of active transportation by the fish, a mussel born of parents in one part of the river may conclude its development in another region, even at points far upstream

from the parent bed or perhaps in some tributary stream that the fish host may have entered.

Investigations carried on by the Bureau during recent years have shown that mussels do not necessarily attach to fish indiscriminately, but that a given species of mussel may make use of only certain species of fish, as the pimple-back mussel (*Q. pustulosa*) seems to be generally restricted in parasitism to certain species of catfishes, and, a more striking instance, the niggerhead mussel (*Q. ebena*) restricts itself so far as is known to the river herring, or blue herring, *Pomolobus chrysochloris*.[a] Conditions, therefore, which affect the movements of the river herring or the catfish may vitally affect the welfare of these important mussels.

It is not here simply a question of whether mussels will be transported from below the dam to the waters above, but, if the river herring is a truly migratory fish, going down the river in the fall and ascending again in the spring, and, if its course is so checked by the interposition of a dam that comparatively few find the way into the upper river, two results will follow: The fish will become a rare species in the upper river, and the future generations of niggerhead mussels will so generally fail of finding attachment to the only suitable fish, that successive broods will perish, until, with the ultimate death or capture of the old mussels, the species will become extinct in that portion of the river lying above Keokuk; that is to say, in practically the entire Mississippi, for the mussel resources of the Mississippi proper (tributaries excluded) are exceedingly limited south of Keokuk.

On the other hand, it is not to be lost sight of that the flood region of the repressed water will make available new bottoms for clam beds. The future condition is not to be predicted. None of the existing bottom of the new lake is definitive. Bottoms now covered with former land vegetation will acquire a new character in time as they are covered with silt or stream-washed sand. The old channel itself, no longer washed as before by active stream action, will undergo changes. The Des Moines Rapids was formerly the home of abundant niggerhead shells of particularly good quality, which could readily be taken from among the rocks. Deeply submerged as these beds now are, it will be scarcely possible to obtain the mussels. The gradual accumulation of silt over and among these rocks will probably make conditions unfavorable for this species, although other beds of different species may be expected to be formed

[a] In some publications the name "skipjack" is applied to this species. Except as derived indirectly from books, that common name does not seem to be applied to this species by local fishermen. The name "skipjack," in fact, seems generally to be appropriately applied to the gizzard shad, while the *Pomolobus* is generally and very appropriately designated as the "river herring," local fishermen having correctly recognized its close relationship to the true herrings. It has been learned, however, that the Ohio shad (*Alosa ohiensis*) is not regularly distinguished by fishermen from the river herring. To avoid further confusion the use of the term "skipjack" as applied to *Pomolobus* should be discouraged.

in other parts. A river-lake[a] fauna of mussels may replace a strictly river fauna. Should Lake Cooper eventually rival Lake Pepin—a condition scarcely to be hoped for—it will be one of the most important mussel regions of the country, supporting a mussel fishery exceeding anything known in this territory before.

In concluding this introduction, certain salient points which have been brought out or implied merit a particular emphasis.

(1) While the value of the dam will never be measured by its relation to the fishery, the effects, both direct and indirect, will be of exceptional interest and importance. There will be advantage not unmixed with disadvantage.

(2) There is a possibility worthy of serious inquiry that some provisions may be made to lessen the incidental injury to fish life.

(3) The dam will afford a unique opportunity for the study of the movement of fishes in the river, if systematic and continuous observations be undertaken in the early spring and continued through the summer.

(4) The new-formed lake offers an equally unique opportunity for the study of the development of the proper biological conditions for fish life. It would be not only a fascinating study, but one of most vital significance, to trace the development of this lake from a condition of infancy to one of maturity, were there available the means necessary for such an investigation.

(5) The opportunity afforded by this new body of water brings the responsibility of taking definite measures for stocking it with suitable fish and mussels; and scarcely less important is the introduction of suitable aquatic vegetation which otherwise, as our experience at Fairport indicates[b] will be slow to find a desirable development.

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[a] By "river-lake," I mean such a body of relatively still water as would ordinarily be called a lake, which is yet intimately connected with a river, either as interpolated in the course of the river, or as an arm of a river. The conditions in a body of this kind may be characteristic. With the opportunity for the internal circulation, plankton conditions and community life, corresponding in some degree to typical lakes, there are combined in a measure the features of circulation and regular renewal of water corresponding more nearly to usual river conditions. Illustrations are Cross and Pokegama Lakes in Minnesota, Lake Pepin and Lake St. Croix, and in a smaller way, Rice Lake at La Crosse, Wis., which is between the Mississippi and Black Rivers and connected with both. Lake and river faunas are generally quite distinct in character. In fact, it is rare for a lake to yield commercial mussels. In the instances just mentioned we find, however, characteristic river mussels, and, what is more striking, we find that a species such as the so-called fat mucket (*L. luteola*), which is generally abundant and worthless in true lakes, is in these river-lakes abundant and valuable—that is, it has a shell of such thickness and form as to be exceptionally useful for buttons. The adaptations of this species is an interesting chapter in itself. No other species of mussel is so generally worthless and, at the same time, so exceptionally valuable and abundant in particular regions. Are its good qualities attributable to the unusual combination of river and lake conditions, or are they characteristic of a geographic region? Will the same species attain importance in Lake Cooper? When the latter question is answered, as it will be in course of a few years, the answer to the former question will be supplied at the same time.

[b] The Bureau through the Fairport station has already made some plants of fish and mussels, and since this paper has gone to press has undertaken a preliminary study of the plankton of portions of the lake with a view of tracing in this and subsequent years the development of the content of fish food. Further observations are inserted in another portion of the paper.

(6) The lessons which can be learned at Keokuk, if the opportunity can be availed of, will be of far-reaching importance as supplying a basis of information for guidance in future developments upon the Mississippi or upon other rivers.

PRELIMINARY OBSERVATIONS.

In June, 1913, it was brought to the writer's attention that the Keokuk dam was being filled with water and, therefore, that a portion of the river bottom below the dam might be exposed for observation. The idea immediately occurred that the practical stoppage of water during the process of filling might cause the congregation of large numbers of migratory fish below the dam, including the river herring which had for some time been sought without success both at New Boston and at Fairport. Mr. Thaddeus Surber, being then engaged upon the investigation of the river herring, was therefore advised to proceed to Keokuk in the hope of finding the desired fish and of securing needed mussels if beds were indeed exposed. The expectation in regard to the fish was fully realized. The fish which had been sought fruitlessly at Fairport and New Boston were found abundantly immediately below the dam.

After an inquiry from the Mississippi River Power Co. regarding the movement of fish, a second visit by Mr. Surber was made July 10 and 11. He reported almost incredible numbers of fish lying just below the dam, large numbers of which were being caught by local residents using hook and line, dipnets, hay forks, etc. During this visit the gates were closed on the Illinois end of the dam, thus leaving the new bed of the river fully exposed where previously there had been water 3 to 6 feet deep. Vast numbers of fish were left stranded and struggling about in the little pools among the large stones, and people from both sides of the river were reaping a harvest, some with gunny sacks filled, others with the larger fish slung on poles, while others still were contented with long strings of fiddlers, sheepshead, etc. He estimated that 1½ tons of fish were removed in the course of a couple of hours.

Below the dam on the 10th and 11th the following fish were observed, given in order of their abundance: Buffalo, carp, paddlefish, sturgeon, sheepshead, fiddlers, redhorse, bluefish (*Cycleptus*), toothed herring, and hickory shad. Very few bass and crappie were taken, though they were reported to be unusually abundant; no *Pomolobus* at all were secured, and, according to local informants, none had been taken for several days previously.

I visited the dam September 22 and 23 and again October 11–15, 1913. The administration of the company courteously granted passes for examination of the dam and its works and extended all

information requested. The lock was also operated for purpose of demonstration.[a]

DESCRIPTION OF THE KEOKUK DAM.

The figures and essential data regarding the construction plan are largely gleaned from a lucid description of the dam comprised in a booklet entitled "Electric Power from the Mississippi River" and issued by the Mississippi River Power Co., at Keokuk in 1912 and 1913.

The plant consists of the following principal elements (see pl. II): A dam proper, 53 feet high over all and four-fifths of a mile long, extending across the Mississippi from the Illinois shore at Hamilton and connecting at its western end with the power house, which is built in the river several hundred feet from the Iowa shore; the power house has its length almost parallel with the river shore, extending in a downstream direction from the terminus of the dam proper, and is practically one-third of a mile in length, over 132 feet wide, and with the great height of 177 feet 6 inches or from 25 feet below the surface of the limestone river bottom to nearly 110 feet above the surface of the lake at high water; the lower end of the power house (one-third of a mile below the dam) is joined to the Iowa shore by a series of constructions, including a section of dam about 100 feet long, which provides a narrow chute and houses the machinery for operation of the lock and dry dock, the lock 110 feet wide and 400 feet long, inside dimensions (618 feet over all), and the dry dock, 150 by 463 feet.

It thus appears that a bay or harbor of considerable size is formed between the power house and the Iowa shore, limited on the lower side by the lock and dry dock. This is called the fore bay and is protected on its upper side by a curved ice fender composed of concrete arches in a series 2,325 feet long and 300 feet of floating boom which may be opened back during the navigation season. It extends from the upper eastern or offshore corner of the power house (that is, from the western terminus of the dam) to the Iowa shore, the direction being somewhat curved, and the total length about half a mile.

The parts which are of immediate interest to us are the dam, the power house, and the lock.

THE DAM STRUCTURE.

The dam proper is merely for the repression of water and the provision of spillways. It is 4,278 feet long, or, with its abutments, practically 1 mile. (Pl. II.)

[a] I desire to acknowledge the courtesy of Maj. M. Meigs, United States engineer, who extended me the privilege of examination of the lock and facilitated my investigation in other ways.

The dam structure is composed of 119 spans, each consisting of two piers supporting an arch, which upholds a causeway. Between the piers is placed in each span a section of spillway, the part over which the water flows. This bridge-like structure, with the water flowing over the spillway sections, extends from the Illinois bluff, to which it is tied by an abutment, across the river to the upper outer corner of the power house on the Iowa side, to which it is tied by another abutment.

The piers are 6 feet thick, and the distance between piers—that is, the width of each of the 119 spillway sections—is 30 feet. The height of spillways is 32 feet. The upstream face of each spillway section is vertical, the downstream face having a curve designed to conform to the under surface of a body of water of this size and depth running over a vertical obstruction to the current; the spillway face is made to fit the under surface of the water to avoid friction as much as possible; the curve of the downstream face delivers the water in a horizontal direction down the river. (Pl. II.)

The stream over the spillway has a depth between 7 and 11 feet. We thus have at each spillway in use an unretarded waterfall of considerable volume with an abrupt drop of 32 to 40 feet, deflected only at the bottom, where it shoots out among the rocks with immense force in the form of a raging, foaming torrent, dashing against the rocks with indescribable commotion. For the protection of the base of the dam from the erosion due to back currents, a broad, low concrete apron is now being laid to flank the dam on its lower side. It would be impossible for a fish to ascend such a fall from below, or even, in all probability, to pass downward through it and escape alive. This is inevitable to the existence of such a dam, so that the opportunity for fish passage must be sought elsewhere.

Between the top of each spillway and the lower side of the overhanging causeway is an arched opening about 19 by 30 feet which will permit the passage of ice and drift with the water. These openings are partially closed by steel gates, 11 by 32 feet, which work in deep slots in the concrete and serve to control the head within certain limits, as well as to regulate the flow to conform with the minimum requirements for navigation as determined by the Government.

The dam proper is not at right angles to the course of the river below but has a slight downstream direction from east to west, so that the upstream end of the dam structure, as of the entire plant, is on the Illinois side. In ordinary times only a few of the spillways are in use simultaneously, so that the main stream of the river so far as it is determined by the flowage over the spillways—the waste water, so to speak—may be changed at any moment from one side of the river's course to the other through a distance of nearly a

mile. (Pl. II.) In practice it is found necessary to be continually changing the gates in order that all may be in perfect order and no risk be run of any gate sticking or failing of operation at a critical time. The gates are raised or lowered by traveling cranes and require about 13 minutes to lower.

Accordingly, as regards those fishes which are seeking an upstream destination, so far as their course may be determined by the spillway current, they will be directed toward the foot of the dam or to the outskirts of a small sea of raging waters (at one side or the other, or midway of the river), where in any case they are confronted by an impassable barrier. If the stream is suddenly changed by the closure of gates at one place and opening of others in another part, the fish may be left in enormous quantities in the suddenly isolated pools among the rocks, where they are at the mercy of those who would capture them. Just this condition has occurred on some occasions when fish could be taken with clubs and hay forks or with any convenient tool. This condition is more or less inevitable, but its recognition may serve to suggest the necessity for care that the condition be not caused unnecessarily. In any case stringent measures should prohibit the slaughter of these fish and provide for their rescue and restoration to the river. It is probably within the province of the Government, in conjunction with the power company, to prevent the wanton destruction of the fish left suddenly helpless under an emergency condition.

THE POWER HOUSE.

The power house is of great importance, not only as the actual seat of the machinery which converts water head into power in utilizable form, but as the place through which there will always be passing a considerable quantity of water. (Pl. III.) The spillways of the dam, it will be understood, serve only to supplement the flow of water through the power house, taking care of the elements of fluctuation in the volume of the river and of variability in the use of water for power.

The power house is not alongshore, but arises out of the body of the lake, as it were, forming the eastern boundary of the fore bay, for about one-third of a mile (pl. I.) Its exact length as designed is 1,718 feet, but only one section equal to one-half of this length is now completed. The foundation walls of the entire building are, of course, in place as an essential part of the dam as a whole. The outside wall of the building toward the Iowa shore is not built solid to the bottom, but is supported on a series of arches, so that the water from the fore bay has free access to an inner or head bay within the building and extending its entire length. The outer wall of the building, facing the Illinois shore, rises from the downstream

bed of the river and is flanked by the tail-race or tail-bay, an important feature for our consideration. Between the head-bay and the tail-race intervene the turbines or power units, of which there are now 15 installed and 15 more in contemplation. These are arranged in a single linear series from the upper to the lower ends of the house.

The water from the head bay is admitted to each turbine through four gates, each 22 feet high by 7 feet 6 inches wide, the opening being protected by coarse screens or iron gratings, which exclude the passage of large drift, but are not fine enough to prevent the passage of any but the largest fish; the openings between bars of the gratings are 6 by 23 inches. The four intake passageways are of a special design and converge into a single large scroll chamber 39 feet in diameter around the turbine. Other gates or guide vanes at this place control the passage of water into the turbine chamber, whence, after setting the turbines in motion, the water passes down through the enlarging draft chamber out into the tail-bay below. The draft chamber is circular at its upper end just below the turbine, where it is 15 feet in diameter, or about 2 feet greater than the diameter of the water passage through the turbines. At once, however, it begins to enlarge in diameter and take a curved form by which it changes direction from the vertical to the horizontal and changes from a circular to an oblong shape in cross section. The outer openings of the draft tube below are 22 feet 8 inches in vertical diameter and 40 feet 2 inches in horizontal diameter. The bottom of these openings and the bottom of the tail-race is about 25 feet below the bottom of the Mississippi.

Between the head-bay and the tail-race there is normally a head of 32 feet. It is calculated that the velocity of the water at the top of the draft tube, immediately under the turbine, will normally be 14 feet per second, or 9 miles per hour, while at the point of discharge into the tail-race it will be 4 feet per second, or less than 3 miles per hour. The water in the tail-race itself may have a greater velocity.

It has been complained that many fish are destroyed by the turbines. It is possible that descent through the turbines would be fatal, but it is scarcely conceivable that fish in course of ascent would reach the turbines. It is to be remembered that the water passes the turbines in course of a vertical descent of 32 to 40 feet with greatest velocity where the turbines intervene. It is hardly possible that fish would successfully breast a vertical current of such force. It is not generally the swiftest fish that seek the darkest passageways. The blades or buckets of the turbines, of course, though revolving at high speed, are not slashing through the water as the uninitiated might suppose, but are driven before the water. Assuming, therefore, that a fish could make the tortuous passage from tail-race to head-bay against the velocity of the water, the tur-

bine buckets would probably interfere less with its course than the solid walls that confine the water.

There are not infrequent reports of the finding of specimens of the spoonbill-cat or paddle-fish below the dam, with the spoonbill cut or broken clean off. Such injuries are attributed to the blades of the turbines, but the reports have not been as yet of such frequency as to indicate any serious degree of damage.[a]

The bottoms of the lower openings of the draft tubes are 25 feet below the natural bottom of the Mississippi. (See p. 14.) The tail-race is excavated to a corresponding depth from the upper end of the power house down to the region of the lock below. This is, for our purpose, one of the most significant features of the dam. The tail-race constitutes a narrow but deep channel, through which the water used in the power house is conveyed downstream to join the natural main channel of the river on the Iowa side near the bridge. The remainder of the river bed conveys, besides an overflow from this tail-race, only the spilled water from the dam, which may at various times be greater or less than the flow in the tail-race, according to the stage of the river above. It may be imagined that at the ultimate development of the plant the amount of water used regularly in the power house will be approximately equal to the minimum low-water volume of the river, since the storage capacity of the lake is not considerable as compared with the size of the plant.

Not all of the water from the draft tubes will follow the direct course, for the channel is not strictly confined, and a considerable surface current will always overflow from the tail-race toward the body of the river. At the time of this writing (October, 1913) the tail-race is to a considerable extent confined by the old cofferdam; but it is probable that this will be blasted out, permitting more extended lateral overflow. There will always be a strong flow of water in the tail-race corresponding at least to the volume of water required to supply the minimum demands of power. There will probably be little fluctuation of current from day to day at corresponding hours except with seasonal changes of lighting demands, but there will be a regular ebb and flow (considering the tail-race only) in the course of each 24 hours, since the use of electrical power is usually least during the early hours of the morning. This variation is very carefully watched by the company, so that it may be compensated by opening or closing gates over the spillways of the dam to minimize the effect on navigation in the river below.

The tail-race is the one perpetual passageway for water below the dam, and it is of interest to inquire in a later paragraph if the fish which may be attracted against this current may not be deflected by some simple means toward the only avenue of escape into the

[a] Several cases have come under the writer's observation.

waters above. The tail-race will always be comparatively free from drift or ice, which must be screened out above for protection of the turbines. It will not be strictly free of drift below the power house on account of there being in the lower end of the power house a small spillway, or chute, through which drift that has entered the head-bay may be shunted to the tail-race below. Close to this chute, but just without the west power-house wall, is another small spillway for shunting the drift which may collect in the region of the lock.

THE LOCK.

The lock was an essential requirement of the Government in order to provide for the necessities of navigation. It is of particular interest also since it is the only passageway by which it is supposed fish may pass from the lower river to the upper. The lock, built by the proprietors of the dam and deeded to the Government, is located below the power house and inshore from it, the upper eastern corner of the lock being connected with the lower western corner of the power house by a short section of dam provided with narrow spillways, as before mentioned. (Pl. I.) The lock is 110 feet wide and 400 feet long inside and has a maximum lift of 40 feet. The time required for locking a boat through is about 15 minutes. For such a great lift in so large a lock to be accomplished in so short a time requires a most efficient and special arrangement for filling and emptying the lock.

The bottom of the lock (which is 8 feet below the water level at the lowest stage of the river) is a gridiron of culverts, the mains being under the bottom of the walls running lengthwise of the lock, and the crossbars of the gridiron being culverts crossing the lock floor at intervals. The largest of these culverts are 13 feet in diameter and the smallest are 6 feet in diameter. The culverts are cast of concrete around steel lining. The angles in them are so sharp and the water pressure and velocity will be so great that the friction of the water against the concrete would wear the latter if it were not protected with steel. The outlet ends of the culverts discharge on the side of the lock at right angles to the course of the river.

By adjustment of a series of valves the water in the lock is permitted to run out into the river through the culverts. After the boat has entered and the gates are closed, the culvert valves of the filling system will be opened, the water from the higher level of the fore bay will rush through the culverts entering the lock chambers through fifty-seven 3-foot culvert openings until the level within the lock is the same as that of the fore bay, the boat being lifted 40 feet vertically within a few minutes. (Pl. VI.) As soon as the upper gate is submerged the boat may pass out and continue its course through the deep water of the bay and lake. In leaving the lock

the boat passes over the front wall of the lock which is covered by 8 to 14 feet of water, according to the stage of the lake.

It should be remarked that the lower gates, which are of heavy steel truss construction, swing open, while the upper gate is of a new submerging type. This gate is a heavy steel truss containing air chambers below and works up and down in vertical slots of steel. There is also an emergency gate a short distance in front of the regular upper gate which may be used when necessary to repair the latter.

It will be inferred from the above description that the fish would not be likely to enter the lock from below during the process of emptying, since to do so would be to pass through the deeply submerged sharp-angle, culverts or tunnels out of which the water is discharging apparently at enormous velocity. Correspondingly it is not to be expected that they would gain the upper lake from the lock during the process of filling, since to do so entails passing down through the same tunnels against the rush of water under a 40-foot head. It is possible that a few might make their exit in this way after the lock is nearly filled.

It is also clear from the description of the working of the lock that the gate above is not submerged except when the lock is full, nor are the gates below opened except when the lock is empty. In other words, there is no ingress or egress through the gates for fish that are working upstream except when the water in the lock is stationary, which is to say, when ascending fish are least tempted to move in that direction.

Another feature of the lock construction is significant. The upper opening of the lock does not extend down to the bottom, but is largely closed from below by a solid concrete wall over 30 feet high. (Pl. VI). A fish entering the empty lock from below finds 8 feet of water at the lowest stage of the river; leaving the full lock above it finds 8 to 14 feet of water between the top of the submerged gate and the lake surface according to the stage of the lake. To find its way out, therefore, it must make a vertical rise of 25 to 35 feet, without the presence of any definite current to direct its movements, or else, as before mentioned, it may seek its way out through the deep tunnels beneath. How will this head wall affect the movements of bottom-loving fish?

Parenthetically, it may be said that the effect of the unwonted variation in pressure within the lock may have a real (but quite unknown) influence on the movement of fishes. The depth of water in the lock varies from 8 to 48 feet. The possible demoralization of the fish by the turbulence of waters suddenly boiling up from below under a 30 to 40 foot head is perhaps uncertain, though we may infer that its effect would not be the happiest.

As a matter of observation, fish are found in the lock. When the lock is emptied a few fish are often seen stranded on the broad top of the wall at the upper end of the lock. More often, perhaps invariably, some are caught between the rails on the top of the submerged gate when this is raised. The space between these rails is about 8 by 110 feet or 880 square feet. Only a few fish were thus taken under my observation, but I was informed that as many as 50 to 100 had been caught in this way at one time. We do not know whether these fish were going into or coming out of the lock. It is possible that the lock acts as a sort of fish trap into which fish of the immediate vicinity stray, and by means of which some of these fish are transferred infrequently from pool to river, or vice versa, without reference to migratory movement. The lock chamber is a little over an acre in extent (44,000 square feet) and such an area in nature will accommodate a large number of fish without indicating any special assemblage of fish seeking a passage in a definite direction. The actual fact, and the significance of the facts, may be determined only by systematic observations judiciously interpreted.

THE QUESTION OF A PRACTICAL AND EFFECTIVE FISHWAY.

At the outset it may be stated that an ideal fishway is afforded only by the free channel of the river itself. We can not have water powers in the course of the stream, without some sacrifice of the free movements of fishes. Artificial fishways may, however, be practically effective, and locks are sometimes accepted as proper fishways, especially where occurring in the course of canals or narrow streams. It does not follow that a lock will be effective in all situations. Some features of the present case will first be recapitulated.

(1) The position of the lock is near the Iowa shore, from which it is separated only by the dry dock and the Government reservation on filled ground built out from the shore. (Pl. I.)

(2) The width of the lock opening is 110 feet, as compared with the approximately three-fourths of a mile breadth of the river. Its opening is perhaps one-thirtieth of the width of the river.

(3) The location of the lock is out of the principal currents, though not far removed from the important tail-race. It is not certain, therefore, that even a proportion of the fish equal to the ratio of the width of the lock to the width of the river would find entrance to the lake through this chamber. That a considerable number of fish should be found in the lock is not inconsistent with this statement.

(4) The filling and emptying of the lock is accomplished by methods which do not encourage the entrance or exit of migratory fishes during these processes. Fish may freely enter from below when the lower gates are open and, by rising toward the surface, may leave for the lake when the gate at the head is opened; but at these times the

water in the lock chamber is practically stationary. It has been suggested that this defect might be remedied by providing in some way that a slow but practically continuous flow of water might prevail through the lock.

(5) There are factors of pressure and of serious disturbance or turbulence of the water which may have significant effect upon the moving tendencies of fish in the locks.

(6) The lock is operated on an average about nine times a day, during the season of navigation, and requires from 15 to 30 minutes for the passage of one or more boats.[a]

(7) The movements of fishes can not be subjected to rules, nor even accurately defined, except after such patient and systematic observations as have not yet been made.

Any fishway to be effective, must receive the fish at some point of convergence and give them practically uninterrupted opportunity for ascent. The fishway should be in operation at least as early as the ice goes out in spring, and preferably sooner, and it should be so attended and cared for as to be always in unobstructed condition. The lock can not be said to meet these conditions.

The engineering difficulties of providing an effective fishway over a dam 40 feet high and a mile wide are not to be underestimated, and must be given careful consideration. Were it an impossibility to have a fishway under these circumstances, we should simply have to fall back upon the law of compensation and accept a great loss in exchange for a greater benefit. The stakes to be lost are, however, perhaps greater than may at first be supposed. The reduction of important fisheries in the entire upper Mississippi and the possible extinction of one of the most valuable mussels of the same portion of the stream are not to be lightly considered.

It is not impossible to suppose that practically all fish that approach the lower end of the tail-race could be made to converge toward the position of the lock or its juncture with the power house. It is possible that an open weir of coarse-meshed wire netting stretched out as a wing from the foot of the lock entirely across the stream below the tail-race would accomplish this purpose. The feasibility of this is suggested by the fact that the tail-race is so largely free from dangerous drift materials. A decided downstream angle to the wing net would not only increase its efficiency but would facilitate the passage around the end of the weir of the drift not screened out above, even if some attention were required to insure such clearance.

The desirability of a fishway at any point depends upon determination by experiment as to whether a large proportion of the fish could be

[a] Records from the lockmaster's book for a period of 46 days show 224 lockings "down" and 191 lockings "up," or a total of 415 operations.

concentrated at this place. Some simple experimentation is worth while, if only for guidance in case of future constructions. Were there installed a floating boom directed from the lower offshore angle of the lock structure downward and outward across the main flow from the power house, it would be practicable for experimental purposes to supplement this by suspending a weir of coarse-meshed wire netting below the boom. The object would be to determine whether fish in large numbers could be deflected in the direction of the lock. The possibility of a fishway near the Illinois end of the dam, which, as has been brought out, is the point farthest upstream, is also worthy of consideration; although the difficulties are here greater, on account of the exposure to floating ice and other drift, and because of the changes of flow from one part of the dam to another. It is possible that, after the period of construction is entirely passed, it will not be necessary to make entire changes of flow during the season of active migration of the fishes. It may be borne in mind that, on account of the tremendous disturbance resulting at the foot of the spillways, most fish will find their direct approach checked at several hundred feet from the base of the dam, although they may, and do, pass around the region of disturbance to reach the very foot of the dam. Accordingly a fishway having its foot at some distance from the dam might be in position to receive the fish at the uppermost point of direct approach.

Reverting again to the tailrace as a region of unceasing current, one may look down from the platform along the outside wall of the power house upon the upper part of the tailrace, where the big draft tubes are discharging columns of water 25 by 40 feet, directed with great force against the opposite face of the tail-bay some 75 feet from the power house. Meeting this obstruction, the waters are thrown into terrific commotion before they can be turned downstream to follow the direction of the excavated raceway. In this raging, whirling, ebullient current, no fish could find a rest or pursue a definite course. But the water is always overflowing now between the piers of the abandoned cofferdam flanking the tail-bay, and will, after the cofferdam is entirely removed, overflow in a continuous sheet toward the center of the river. This is of interest as a tolerably fixed condition, as opposed to the variable conditions characteristic of the spillway portion of the dam.[a] It appears plausible that fish will work up along this line of overflow, finding ultimately a terminus at the foot of the dam. If it be possible to provide a fishway on the dam at a point near the upper end of the tail-race, it is probable that the opportunity for concentration of fish would be more uniform here than at any other point on the dam proper, and likewise that the problem of preventing damage from floating ice and drift would be simplified

[a] Note the later observations inserted on page 25.

by the proximity of the head of the fishway to the power house and the present ice fender.

The possibility of a dipnet and hoist operated at the angle of power-house and dam, or elsewhere, is suggested by the congregation of fish in such places. None of the suggestions mentioned in this section is offered as a practical solution of the problem; rather as indicating some possible lines of preliminary experiment.

Finally, the question is sometimes asked if fish in migration are working along the bottom or near the surface. The answer is that there are bottom-loving fishes and surface fishes. The essential fact is that a fishway is intended for the use of fish working upstream, or those engaged upon the return journey. Consequently it must be located at a point that fish naturally approach in fighting a current. Needless to say, it should operate continuously, and not intermittently, unless the fish were prevented in some way from seeking another place while waiting for the opening of the way.

It is much easier to proclaim the desirability of a fishway than to say what sort of a fishway and what location for it would be practically effective. The problem which is raised is simply this: To determine by continued observation under varying conditions at what points the fish naturally converge or may, by artificial means, be made to converge; then to inquire what sort of passageway would be practicable and effective to permit and encourage ascending fishes to rise from the river to the lake. When these questions are given a definite answer, intelligent action can follow. If the end is necessary, and practicable of attainment, it is worth expense; if it is not found feasible to converge and give reasonably free passage to migratory fish, it is useless to waste relatively large sums for the name of "fishway." The whole matter at this stage may be expressed as a biological problem, definitive answer to which should not and can not be given except on the basis of further experience.

LAKE COOPER.

It is indeed desirable that ascending fish should have access to the great breeding grounds of Lake Cooper. Regarding the lake, it is not pertinent in this connection to add much to the references made in the introduction concerning its relation to fish and mussel life.

As a region of repressed and relatively slack water, Lake Cooper extends above Burlington, Iowa, with a length of 65 miles and a width of 1 to 3 miles. It will not here be discussed except to remark that it has caused the submergence of many islands and low-lying shoreland and formed numerous deep coves and bays. Much of the submerged farming lands of high value are to be reclaimed by systems of levees and drainage. The growth of trees upon many of the flooded islands and shores has been removed by the company that there

might be no danger to navigation. The maximum lake level is not yet attained; there may be a rise of 3 or 4 feet in the course of the next few years, to be made gradually in accordance with arrangements between the company and the property owners affected. The greatest depth in ordinary times will be about 40 feet, but the general depth will be much less.

There will ensue a good deal of decomposition of old land vegetation under water, but the effect of waves and surface wind currents, in connection with the circulation resulting from the regular flow of the river, will do much to reoxygenate the water. In course of time a proper growth of vegetation will be found in the bays, and this will form a most significant feature in the bionomics of the mature lake.

Experience at Fairport with new ponds supplied with Mississippi River water shows that the development of a proper degree of aquatic vegetation is greatly hastened by artificial introduction of suitable plants, and we have found it difficult to obtain these in any variety from the local overflow ponds and slues of the Mississippi. It would be most desirable, therefore, if the Government or State authorities should make such introductions in the various coves and bayous, so that the maturity of the pond as a fish environment might be expedited. Plants of fish and mussels can readily be made. It is understood that several hundred young bass were introduced by the Iowa State fishery department, and the United States Bureau of Fisheries, through the Fairport Biological Station, made a plant in October, 1913, of 2,343 large-mouth black bass and 425 crappie infected with Lake Pepin muckets and local Mississippi River muckets, in about equal proportions (1,380,000 glochidia in all).

OPPORTUNITY AND RESPONSIBILITY FOR INVESTIGATIONS.

The problem presented by the Keokuk Dam may well serve to point out the inadequacy of our preparation to deal with situations of the kind -situations which may vitally affect the future food supply of our people. It is not alone an insufficiency of knowledge and experience which confronts us, but a real negligence. In connection with water-power developments everywhere, streams are obstructed with the bare and indefinite requirement for installation of fishways, which, in a large number of cases, become inoperative soon after they are put in. It is not the proprietors of the power developments who are at fault, so much as the public at large who expect the owners to provide and maintain fishways though robbed of incentive and guidance.[a]

The subject of fishways is one of live importance, and one requiring thorough experimentation. It is not the method of laboratory experiment that is needed, so much as that of field experiment and

[a] There are very few sorts of fishways that accomplish the purpose for which they are designed.

continued observation of the movements of fishes and their utilization of fishways. It is unfortunate that more practical experience has not been gained by a strict enforcement of the provisions requiring fishways and subsequent precise observation of their efficient working. In this way would the best of experience be gained.

Passing this subject, there are rare opportunities presented by the situation at Keokuk, to take advantage of which would be of the highest value.

We are deficient in our knowledge of the movements of fishes. What fishes migrate, at exactly what season does the migration occur with the several species of fish, and what is the extent of the movement with the several species? These are questions that we can not now answer with a satisfactory degree of definiteness. The existence of a practical obstruction in the Mississippi at Keokuk offers an unprecedented chance for exact observations, supplemented as they may be by the series of observations made by the biological station at Fairport, in the upper Mississippi at Lake Pepin, and elsewhere. The full realization of this opportunity can not be accomplished by a cursory examination, but demands a systematic and long-continued investigation undertaken before the movement of ice in the spring.[a]

Observations made by the staff of the Fairport station during the summer and fall of 1913 have revealed the fact that the river herring (*Pomolobus chrysochloris*) has been present just below the dam during practically the entire period and in large numbers. Nevertheless, it would be impossible to say at the present time if this is because the fish are blocked in the effort to proceed up the river, or if we have to do only with the assemblage of an exceptional number of individuals of this species due to peculiarly favorable conditions found in the swift waters below the dam.

The peculiar habits of eels are of particular interest in connection with any effective obstruction of the course of a stream. It is known of some species of eels, and believed to be true of all, that they do not breed in the rivers at all, but only in the depths of the ocean. The young eels, after hatching from the egg and passing through an interesting stage called the leptocephalus, during which they are strictly marine, ascend the rivers to grow to maturity, when they in turn will pass down the rivers to start a new generation upon the first stage of life in the sea. Supposing that few of the new generation of eels should succeed in passing above the dam, we would expect a gradual

[a] Anadromous fishes are those which ascend rivers to spawn; the only fish of the Mississippi assumed to be anadromous is the Ohio shad, *Alosa ohiensis*. Catadromous fishes are those that go down to the sea to spawn; such are the eels of the Mississippi River. Other fishes are merely migratory having seasonal runs, from upper to lower portions of the river and return. In this class are generally included practically every important food fish, as the basses, wall-eyed pike, suckers, buffaloes, spoon-bill cat, lake sturgeon, shovel nose sturgeon, river herring, and all the larger catfishes. Very few fishes, among which would be the bullheads, would be left in the nonmigratory or permanent resident class. However, it must be said that the beliefs regarding the movements of fishes require to be submitted to the test of more exact observation.

extinction of the eel in the upper river and its tributaries, while we would look for a relative abundance of young eels below the dam, particularly during the next few years. This is a problem that may lend itself to concrete observation.

A question that raises itself in regard to purely migratory fishes, that is, those that move down the river in the fall and up in the spring, is, to what extent will the presence of the large body of deep water above the dam remove the necessity, or inhibit the tendency, of the fishes to proceed farther in their downstream course?

The destiny of the fish that are interrupted in their upward journey upon reaching Keokuk introduces a new problem. What becomes of these fish? Will they remain there all the summer? Will they turn back and work down the river or find tributary streams? To answer such questions would require close and continuous attention during the spring, and, since the fish can not be watched by the eye, a good deal of systematic trapping and seining at various points. In this connection it may be mentioned that reports were current to the effect that the Keokuk dam had turned innumerable fishes up the Des Moines River, which discharges into the Mississippi only 3 miles below the dam. It was said that more fish were being taken at Ottumwa than could be disposed of. Both Ottumwa and Eldon were visited by the writer in September, and the most careful inquiries made. It was found that the reports had no foundation, other than the hope and belief that the dam would deflect the fish into the Des Moines River as the first opening below Keokuk. Some local persons who did not fish offered some supposed confirmation of the reports, but every one of a considerable number of persons interviewed who fished either as a profession or for sport, agreed in stating that the fishing had been unusually poor during this season, and this condition was attributed to the fact that the river had been too low all the season for fish to ascend. There was some testimony that there had been an unusual run of very small channel cats and carp of 6 or 7 inch length—almost too small to use—but it did not appear that this had been unprecedented; also there was complaint of an increasing number of gars.

The sudden creation of a large lake intervening in the course of a great river with the submergence of islands and shore land, thousands of acres in extent, offers an unrivaled opportunity for investigations of material value. Upon this subject we are at liberty to some extent to draw conclusions a priori, as has been done, but there is none the less the privilege and the responsibility for more detailed inquiry and exact survey which, if completed, would furnish invaluable data for interpretation of the conditions of fish life and the determination of the ultimate requirements for the maximum development of fishery resources.

The problems here outlined are too extensive in scope to be solved in their entirety within the available resources of the Bureau, but the hope may be expressed that the lesson of this occasion may make so wide an impression that, should the fortune of time offer another situation of like significance, the possibilities of the Bureau's service may have been so anticipated that a condition of preparedness shall have been created. The effective conservation and development of the fishery resources is a not unimportant phase of the provision for the future welfare of the country.

Appendix.—The Problem of the Migration of River Herring.

The following brief account of observations made chiefly during the year 1914 are of interest in this connection. While it was not found feasible to detail anyone for continuous study of the succession and movements of fishes, as would have been desirable, some occasional visits could be made, which were not without value.

The writer visited Keokuk April 15, 1914, when the water was still cool, and practically no movement of fishes had occurred. It was learned that the river immediately below the dam had remained open all the winter, although as a whole below the bridge at Keokuk and above the dam it had been frozen over with thick ice. In the exposed water the wall-eye or "jack salmon" had been present all the winter and fished abundantly with hook and line. Practically the only fish then in evidence were perch and crappie in the slues. A few perch were noted in the lock, and the lock master stated that a large number had been taken at the first locking, about April 10.

A local informant, Mr. Joe MacAdams, was requested to write me of the first appearance of the herring. After a card from him, I visited Keokuk again April 29. He stated that the herring first appeared April 20, and that they became enormously abundant within a few days; on the 27th, according to several informants, during a warm day, one could at any moment see hundreds of them breaking the water in every part of the river below the plant.

The day of my arrival, April 29, was cold, windy, and cloudy, and at first view very few herring were observable. After closer observation, however, they were seen to be present in immense numbers, and congregated in certain locations exactly as had been predicted. (See p. 20 above.) A large number were seen just below the short section of dam between the upper end of the lock and the lower end of the power house; many were observed along the outer wall of the tail-race, but in the angle between the power house and the dam and from this point to the nearest open spillway, a short distance away, the herring were fairly massed. Such a close aggregation of fish can rarely be seen in fresh water. They had evidently followed up along the outer edge of the tail-race until they could go no farther. Again, on

the outer side of the last spillway in use, which was about 700 feet from the power house, there were considerable numbers of herring. From this point to the Illinois shore, a distance of about two-thirds of a mile, not a single herring was in evidence. It was evident, therefore, that the herring had been guided by the moving water, so that they had in consequence assembled in such remarkable numbers on each flank of the stream below the open spillways, many more being guided to the eastward side by the strong current from the turbines.

Opportunity to observe whether they could breast the strong current was favored by the fact that there were three closed spillways between three open on the east and nine open on the west; thus there was a triangle of relatively slack water between two strong currents which met a short distance below. To the west of the westward current fish were abundant; to the east of the eastward current they were still more abundant; but in the triangle between not one fish could be seen. It was evident, therefore, that the power of the currents below the spillways proved an effective barrier to the lateral movements of the fish for some distance below the dam; otherwise not all of the fish would have been on the right side of one current and on the left side of the other.

The powerful currents caused slight eddies on each side, so that the dead water at the foot of the dam on either side was continually being drawn into the spillway streams. The fish were also drawn in, and it was easily observed that the velocity of the streams made them perfectly helpless. As soon as they passed into this stream they were thrown up in the foam and spray and often hurled 20 feet or more, back, sides, or under parts up, to be carried off as soon as they fell. Presumably no injuries were received, as no dead or injured fish were observed in the river below. No fish, as previously indicated, were drawn in from the slack water between the easterly spillways and the westerly, although similar eddies prevailed here.

It was observed that the roe of the herring was large, and it was thought that they would ripen within a few weeks. A visit was made by Superintendent Canfield May 29, and a number of herring were examined, but they were found to be not quite ready for spawning. A later visit was made by Mr. W. B. Gorham, June 11 and 12, when it was found that the herring had disappeared. This disappearance had not been noticed by the local fishermen for the reason that there were present in large numbers the Ohio shad, *Alosa ohiensis*, which is not generally, if ever, distinguished by fishermen from the herring. There was no clue, therefore, as to what had become of the herring.[a] Later observations at Lake Pepin are mentioned below.

The gathering of herring in such enormous numbers at Keokuk is of particular interest from the fact that this fish has never been gen-

[a] Later observations (in August) indicate that the disappearance was only temporary.

erally regarded as abundant in the river. Fishermen generally speak of it as uncommon, and yet informants sometimes refer to occasions when they were taken plentifully about the ends of wing dams. It has been supposed, therefore, that the fish is more abundant than common observations indicate, but that it migrates rapidly, keeping in the current where fishermen work least, and tarrying where the water runs swiftly around such obstructions as the wing dams. This supposition seemed to receive confirmation from the observations at Keokuk in 1913.

The question still occurred: Would the herring be found in the upper river after the dam was constructed? On the occasion of a visit by the writer to Lake Pepin in Minnesota on July 19, 1913, a single specimen was taken in a seine haul of our propagation crew. Several fishermen were positive that this was the first specimen seen in Lake Pepin in that season. The foreman of the crew, Mr. William Teachout, was requested to report each subsequent catch, and following is a record of his reports. To check the field identifications, specimens were sent to the Fairport laboratory from time to time, and in each case the identification was confirmed. The seining operations were discontinued in Lake Pepin after September 11, though pursued in the river below the lake. Later hauls in Lake Pepin were made October 17, 18, and 23, without further catch of herring.

Blue Herring Taken in Lake Pepin During 1913.

July	29	8	
Aug.	3	53	
	9	1	
	12	5	
	23	8	
	26	12	
	27	8	
Sept.	3	3	
	5	25	
	6	5	
	11	26	

The observations at Lake Pepin were continued after the seining operations began in Lake Pepin in 1914. A single specimen was taken May 12, a few about the middle of June, after which they were taken more plentifully, especially in July, as shown by the records which follow, covering observations to the date of August 8:

Blue Herring Taken in Lake Pepin During 1914.

May	12	1	
June	15	1	
	17	1	
	19	3	
	22	28	
	23	8	
	24	14	
	25	3	
	26	1	
	27	12	
July	1	5	
	9	1	
	10	40	
	11	168	
	20	135	
	21	3	
	22	120	
	23	29	
	24	92	
Aug.	3	57	
	7	75	
	8	1	

The fact that the herring became abundant at Lake Pepin shortly after they ceased to be observable at Keokuk suggested that they might have passed through the lock. However, the examples received from Lake Pepin were noticeably smaller than the examples taken at Keokuk. This fact suggested the inference that the Lake Pepin herring might not have come from the river below Keokuk, but might represent younger fish that had wintered at intermediate points or possibly in Lake Cooper. Here the matter must rest pending further and more adequate studies. It is noteworthy that the herring seem to have appeared in Lake Pepin earlier in 1914 than in 1913, and that they appeared to be more numerous in the later year, notwithstanding that the river was obstructed at Keokuk throughout 1914 but not in the earlier part of 1913.

In August, 1914, a number of very young herring were collected by Mr. Teachout. In one shipment, August 26, 1914, 21 specimens were received of fingerlings or yearling herring, the lengths ranging from 122 to 165 millimeters (5 to 6½ inches). On September 5, six somewhat smaller specimens were sent us, having lengths of 107 to 128 millimeters, the smallest being scarcely over 4 inches. Such specimens are of particular interest as the first young herring observed at our laboratory and as indicating that Lake Pepin is a place where the herring breed. Mr. H. W. Clark, who has examined these specimens, reports that even many of these small herring are infected with glochidia of mussels.

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GENERAL VIEW OF THE WORKS OF THE KEOKUK-HAMILTON DAM FROM THE IOWA SHORE.

Hamilton, Ill., in the distant background, showing the dam structure, completed half of the power house, foundation of half of power house not completed, the lock, and the region of dry dock and Government shops where excavation and fill is in progress. On the left in background is the lower portion of Lake Cooper above the dam, and the forebay between power house and foreground. A portion of the ice fender near the power house is barely seen on the extreme left.

VIEW OF THE DAM STRUCTURE SHOWING THE ARRANGEMENT OF SPILLWAYS; ALSO THE TAIL-RACE FROM THE POWER HOUSE ON THE LEFT.

A temporary cofferdam separating this tail-race from the river proper is seen in this photograph, but it was subsequently largely removed.

SWIFT TURBULENT WATER DASHING AGAINST OLD ROCKS BELOW THE SPILLWAYS.

PLATE III.

SECTION BELOW THE DAM WITH SIX SPILLWAYS OPEN. NORMALLY A MUCH GREATER NUMBER OF SPILLWAYS ARE CLOSED.

POSITION OF THE LOCK WITH REFERENCE TO THE LOWER END OF THE POWER HOUSE.

From left to right: (1) lower end of power house; (2) short section of dam between power-house foundation and lock; (3) the lock with forward emergency gate raised; (4) the dry-dock in construction with gate raised; (5) filling for Government shops in progress; (6) Keokuk bluffs at extreme left. Water is being passed through the gates of the lower unfinished portion of the power house.

PLATE VI.

ITO THE BOTTOM OF THE LOCK. THE VALVES HAVE JUST BEEN OPENED.

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